The Foundry Trade Journal

AND PATTERN-MAKER.

THE OFFICIAL ORGAN OF THE BRITISH FOUNDRYMEN'S ASSOCIATION

Vol. 13. **MARCH, 1911.** **No. 111.**

PUBLISHED THE FIRST WEEK IN EACH MONTH.

Subscription Terms: 7s. 6d. per annum, post free.

To place the "JOURNAL" within the reach of Working Moulders and Pattern-makers the Proprietors will accept subscriptions, not less than three in number from one shop at the reduced rate of **5s.** per annum, such order to be countersigned by the superintendent or foreman.

All communications to be addressed to the Editor, or to the Publisher, as the case may be, of

THE FOUNDRY TRADE JOURNAL,
165, Strand, London, W.C.

WE INVITE PRACTICAL ARTICLES ON THE TRADE IN ALL ITS BRANCHES, WHICH WILL BE PAID FOR. MSS. SHOULD BE WRITTEN ON ONE SIDE OF THE PAPER ONLY.

BRITISH FOUNDRYMEN'S ASSOCIATION.

LIST OF SECRETARIES—

General Secretary: J. E. H. Allbut, "Meadow Lea," Highfield Road, Stretford, Manchester.

Manchester: H. Sherburn, Rotherwood. Stockton Heath, Warrington.

Birmingham: George Hallstone, 97, Katherine Street, Warley, near Birmingham.

Cardiff: H. Griffiths, Messrs. J. Williams & Sons, Ltd., Globe Foundry, Cardiff.

Sheffield and District: R. W. Kemlo, 6, Lees Hall Road, Meersbrook, Sheffield.

Glasgow: J. A. Ewen, 124, Pollok Street, S.S., Glasgow.

London: T. Murphy, 21a, Brooksby Street, London, N.

Contents.

	PAGE
Notes and Comments	129
The Growth of Heated Castings	131
British Foundrymen's Association: Birmingham Branch	132
The Application of the Microscope in Foundry Practice	136
Repairing Moulding Flasks and Boxes	141
The Installation and Use of Abrasive Wheels in Foundries	142
The Installation and Equipment of a Small Brass Foundry	144
Melting Aluminium and Magnesium Scrap	149
Setting Pattern Parts in Tops or Copes	150
Points of Dispute between Pattern Shop and Foundry	152
Some Methods of Testing Materials of Construction	153
Briquetting Iron Turnings in the Cupola	154
Tufnia Flux	155
British Foundrymen's Association: Formation of a London Branch	156
Recent Progress in the Electro-metallurgy of Iron and Steel	157
Volume Changes in Cast Metals	158
Queries and Replies	160
Electric Steel Refining	160
The "F.T.J." Bookshelf	162
Foundry Plant and Equipment	163
Inventions	166
Industrial Training	169
Deaths	169
Trade Talk	170
Personal	172
Prices of Metals	174
New Companies	174

Forthcoming Events.

MARCH 11.

British Foundrymen's Association (Scottish Branch).—Monthly meeting

MARCH 14.

British Foundrymen's Association (Sheffield Branch).—"A Comparison of British and Continental Foundry Practice," by J. Shaw (Dudley).

MARCH 25.

British Foundrymen's Association (Birmingham Branch).—"Some Alloys of Alluminium," by Mr. Fred. C. A. H. Lantsberry, M.Sc.

NOTES AND COMMENTS.

London as a Foundry Centre.

As reported on another page of this issue, last month witnessed an important event in London foundry circles, i.e., the inauguration of a London Branch of the British Foundrymen's Association. This youngest of the offspring of the Association received a hearty send-off in the presence of a representative gathering of London and South of England foundrymen, the meeting being presided over by Mr. Percy Longmuir, B. Met., President of the Association. Its progress now will depend largely on the energy of its officers, of which we are assured, and the interest which London foundrymen take in their own education and progress. It may be still contended, as it has been in the past, that London is not a foundry-trade centre, and that a Branch of the British Foundrymen's Association is not justified there. But even if this be admitted, we may ask, "Is London a centre of the iron and steel trade, of mechanical engineering, electrical engineering, or of mining? The answer in each case is obviously, "No"; but nevertheless, we find the headquarters of the Iron & Steel Institute in London; we find the Mining Engineers and the Electrical Engineers in the same centre, while the Institution of Mechanical Engineers have also established their magnificent headquarters there. Further, we understand that other technical societies, which now have their central offices in the Northern Counties, also contemplate removing them to the capital. The truth is, London may not be a centre of any particular technical calling, but it is the centre of the Empire, and also the place most easy of access from all parts of the kingdom. Industry of all classes converges on London, and science there has also found a permanent home. Is it any wonder, then, that the shrewd minds which dominate the policy of the British Foundrymen's Association, should turn their eyes to London and see there the most suitable place for the ultimate establishment of headquarters and central offices—for that is one of the objects in view in breaking new ground in the Metropolis by the formation there of a Branch of the Association. It is hoped that, in the future, suitable central offices, equipped with a reference library and reading room for the use of the members, will be established in London, and that the main business of the Association will be transacted from there. The scheme is a laudable one, and will doubtless become an accomplished fact in the course of the next few years: for the progress of the Association has been sufficiently good—not violent and erratic, but steady and sure—to warrant definite prognostications.

But to revert to the question of London as a foundry centre, its claim to be such may not rank with that of Birmingham, Sheffield or Glasgow, but nevertheless, the claim cannot be refuted. There are dotted all over the Metropolis and the surrounding counties, including Essex, Surrey, Kent, Sussex, Middlesex and Hertfordshire, approaching 200 iron foundries, the majority of these being within the London County area; about 150 brass foundries, over half of which are in London; and about a dozen alu-

at Braintree, Essex, and at Rochester, Kent. The foregoing figures, it may be mentioned, consider as separate foundries two departments of the same establishment which deal respectively with two classes of work such as iron and brass. Included are several large plants turning out a considerable tonnage yearly, but many of the foregoing are small shops employing from two to ten men; and though they may not figure largely on the country's annual output account, they are just the establishments where educational work would be most advantageous. Employed in these foundries are many excellent workmen, but they labour often under the restriction of poor equipment, a limited class of work and lack of contact with their fellow craftsmen. It is these men, particularly, that the London Branch of the British Foundrymen's Association should endeavour to enlist, and even though they may not be able to contribute tales of large outputs and important jobs turned out, they certainly can tell of hundreds of difficulties encountered and mastered unaided. London's brass foundries alone form an important industry, and it is with pleasure we learn that Mr. Percy Longmuir has consented to give the first lecture before the new Branch, the subject to be some phase of brass-founding. We are sure that our London men will appreciate any such service rendered from those well advanced in metallurgical science, and at the first London meeting a good attendance may be expected. As regards the growth of the parent Association, it may be remarked that this still continues steadily; at the Council Meeting on February 25th, 12 members, 23 associate members and 16 associates were elected to the Association.

Briquetted Turnings in Cupola.

On another page we publish an article giving some interesting particulars on this subject by a German investigator who, on the whole, appears to regard favourably the system of using briquettes. In an article by E. Leber, which we published in our January issue, it will be remembered, the claim was put forward that these briquettes are an improver of cupola iron, and that they confer physical properties not to be obtained from other analogous materials. This claim should not be admitted by ironfounders until they themselves have proved the truth of it in actual practice. It is not quite clear what is meant by "analogous" materials, but presumably pig-iron is included in this classification. If unbriquetted turnings or other fitting-shop offal are the only other analogous materials, the superiority of briquettes may be admitted, and there is no quarrel with briquettes as a purely economical move. Where iron turnings or filings are melted loose in the cupola, and this has often been attempted, anything up to 75 per cent. of the charge may be lost. Where cheapness of metal is the only matter of practical importance, as it may be in many branches of foundry work, this system may be of value. But these briquettes are put forward not only as something cheaper than good pig mixtures but as something superior, and certain attributes and potentialities are claimed for them which are of surpassing value and not to be found in pig-iron. Now, before an ironfounder buys these briquettes, and certainly before he lays down any plant for making them or dealing with them, he ought to carefully sift the evidence proffered as to their value as a raw material for good castings, and consider the probability of the curious phenomena said to accompany their melting actually occurring, either at all or to an estimable or governable extent. In the article by Herr Leber is was suggested that the use of briquettes lowers the carbon content of iron, and this is placed against the stated fact that with ordinary pig mixtures the percenage of carbon is raised considerably. This latter statement is, as far as most ironfounders' experience goes, quite erroneous. The variation in the carbon content of any iron melted in the cupola furnace is practically negligable. The carburization of iron on anything like a calculable scale requires a much higher temperature than that usually commanded in the foundry cupola, or it requires a much longer time than the iron charge in a cupola could possibly be allowed to remain compatible with anything like a decent quality of metal tapped. In a blast furnace the question of carburization has to be reckoned with (the temperature just over the tuyeres probably rising by as much as 500 degrees C. above that of a cupola), but not in a cupola. As regards the reduction of carbon when briquettes are used, this is a statement no doubt based on experiment. The reasons suggested to explain it must, however, be carefully examined,, and they open up a wide field for discussion. Supposing it be true that, through their porosity and lack of density, the briquettes give up some of their graphite in the upper cupola zones, the graphite would be really blown out, not burned out, and from this it would be imagined that a good deal more of the briquettes is blown away than the free carbon, and that there is a big melting loss. Herr Leber himself puts this at 8 to 10 per cent., and it may be very much more. It is very difficult to square this theory with the one previously laid down in the article, that the briquettes melt like broken pigs, as it would be thought that an iron or an iron-conglomerate giving up its graphite carbon so quickly and easily would melt very much more rapidly than pig-iron, and if the briquettes do thus melt before the pig, and descend first in this way in the form of metal holding a very low carbon, it would be very difficult for this metal to mix thoroughly with the rest of the charge when the latter came down. Naturally, a reduced carbon is of great value, even if 10 per cent. of the charge is lost, providing that low carbon is equally distributed throughout the casting; but it is the difficultv of achieving this that is to be feared. It is, in fact, hinted that the desirable features in the briquettes may be lacking in the case of those who do not know how to work them, but no indication is given of any special way in which they should be worked.

Effect of Briquettes on Sulphur Content.

The bold manner in which the enrichment in sulphur is put forward as a point in connection with briquettes is deserving of some praise, as there are many who are opposed to the low-sulphur theory At the same time, it is hardly advisable to employ a material which will absorb sulphur in this way, since it is an element most potent in its effect, and the figure at which it is required to stand in the metal when tapped should not be partly estimated on very doubtful and obscure reactions taking place in the cupola. Mr. Leber says it is sometimes advisable to add silicon in the ladle. This procedure is very often objectionable, and in any case, how is the founder to judge those occasions upon which it is needful? Further, the founder appears to be obliged to use a specially low sulphur coke, and this is vexatious, as many cokes carrying fairly high sulphur are very economical owing to hardness, structure and heating power, and it is very useful not to have to reject a coke on account of its sulphur content. This danger is, however, possibly exaggerated by Herr Leber, since he is probably wrong in suggesting that the molten iron takes up sulphur in contact with the coke in the lower cupola zones. It is only volatile sulphur that iron absorbs in the cupola and this will be in the upper zones as sulphur dioxide or as sulphuretted hdvrogen resulting from moisture in the air-blast. He also makes out the case against sulphurminium foundries. Steel founding is only represented at two places in the area under consideration, viz.,

much more strongly than is necessary, by a sweeping attribution to sulphur of air bubbles and porous castings. Sulphur may liberate gas, but it should not control the range of fluidity of foundry iron, which can easily be governed by phosphorus and manganese, and gas or air shut up in any metal having a fair range of fluidity is almost certainly the result of either a wrong sand mixture, tight ramming, insufficient venting, or metal poured too dull, or of all of these. The greatly increased de-siliconization spoken of is clearly a factor to be reckoned with, and a very uncertain one. A case is stated where 50 per cent. is lost. Is this an average rate of decrease in the briquettes whatever their original silicon? This is a most important point. As regards manganese, the statement that this increases must be accepted, but it is impossible to offer any solution of so strange a phenomenon.

The sum total of the facts does not hold out much assurance of successful working. The cupola is a melting machine, and that founder can best rely on a successful and predetermined result who can bring his iron out at the spout the nearest in chemical composition to what it was when he charged it. To use a material which loses carbon considerably and silicon up to 50 per cent., and gains both manganese and sulphur very considerably, or is expected to do all these things for unexplained reasons, and which may at times require doctoring in the ladle, savours too much of the method of trusting in Providence, which, as all those experienced in the trade know, is apt at times to mete out every scurvy dispensations in the foundry.

The Growth of Heated Castings.

A joint meeting of the Birmingham Branch of the British Foundrymen's Association, with the Birmingham Metallurgical Society, was held at the Technical School, Birmingham, on Friday, February 24, when a Paper was read by Dr. H. C. H. Carpenter, M.A., Ph.D., on "The Prevention of the Growth of Cast Irons after Repeated Heatings." Professor T. Turner, President of the Birmingham Metallurgical Society, occupied the chair.

Professor Carpenter gave instances of expansion, recalling in particular a famous lawsuit in which the case was lost because the Judge would not believe in the fact of cast iron expansion. Such growth was very common in cast-iron rolls, firebars, ingot moulds, etc. The speaker recalled the experiments of Mr. Outerbridge, of America, who decided that the change was purely of a physical character, generally leaving the weight unaffected. Following these investigations, Dr. Carpenter conducted experiments himself. He found that, starting with a temperature of 600 degrees, up to 800 or 850 degrees, approximately constant growth was obtained in three hours, while irons containing iron and carbon, whatever the amount of carbon, providing it was less than 3½ per cent., did not grow under heat treatment, even after 90 heats. But an important exception was an alloy containing 4 per cent. of carbon, which after 90 heats had grown 7 per cent. In another series of alloys they varied the silicon from 1 to 6 per cent., having the carbon practically constant. The castings grew approximately in proportion to the growth of silicon. These grey irons grew more quickly at the ends, on account of the greater exposure to gases. The speaker concluded that the fundamental factor in the growth of grey cast irons was the percentage of silicon. All the bars increased considerably in weight, also in proportion to the amount of silicon. The growth progressed more quickly nearer the gate of the casting, and the increase in weight was almost entirely due to the oxidation of the silicon in the iron. There was also a slight burning off of the carbon, with a very close connection between the growth in size and weight. The penetration of gases from the furnace was also a very important factor. Various experiments were made to test the effect of gases. It was found that a bar heated "in vacuo" did not grow when gases were extracted. But when re-heated in the muffle furnace with exposure of gases, there was a growth of 6 to 7 p.c. He concluded that it was the gases dissolved in the cast iron which caused the cracking, and that the growth of the iron was due to the reaction between the muffle gases and the iron.

Dr. Carpenter proceeded to outline in general terms various conclusions arrived at as the result of further investigations, full details of which are to be given in a paper prepared for the next spring meeting of the Iron and Steel Institute, to be held in May. He would be able to show that graphite and silicon were the two fundamentals present in cast iron which exhibited growth. Other constituents such as manganese, sulphur and phosphorus had only very slight influence, or even a retarding influence.

He did not think the furnace gases were absorbed to any great extent during heating. The reaction between the incoming gases and the iron did not take place until the iron was cooling. Then the oxides in the carbon reacted with the iron silicides, forming silica iron, and the product of the gases formed little cracks in the material. Possibly, also, there was a slight explosive reaction. With re-heating the gases penetrated a little further and that happened with each re-heating. The greater the growth, the greater the deterioration, until eventually on complete growth the material had ceased to be metal and could be sawn almost like a piece of chalk. The problem would be easily solved by keeping down the silicon but for the fact that such restriction produced brittleness. They must conclude that grey iron was not amenable to treatment for reduction of growth, because of the graphite plates in the silicon. They must have an iron with sufficient carbon to be fusible, but with not sufficient to deposit the temper carbon which produced growth. He had been, for the past eighteen months, working at that problem, and he wished to acknowledge the great practical help he had received from Mr. Fletcher of Dudley. He believed manganese would furnish the key to the situation, having two valuable properties in white iron, keeping the carbon in the combined state and rendering the iron tougher. Manganese in white iron did not show a pronounced crystalline structure associated with brittleness to anything like the same extent as carbon alloys. At the May meeting of the Iron and Steel Institute, he hoped to give particulars of some of those alloys which after 150 heatings, each of four hours duration, up to 900 deg., had not grown at all, but slightly contracted. At no time did it reach ¼ p.c. He had obtained a white iron which fulfilled those conditions, and would be useful for many purposes. (Applause.)

Messrs. Lester, Hailstone, Cook, Vaughan Hughes, and others spoke very appreciatively of the paper. Dr. Carpenter, replying to questions, said no doubt the superheating of steam was causing deterioration of the cylinders through growth, and cast-iron valves were particularly affected. The increase in gas-stove grids was a very serious matter. He strongly hoped his special alloys would prove very useful for annealing ovens, stoves and similar purposes. But they would not do for steel ingot moulds, which were subjected to a very severe strain.

A hearty vote of thanks was accorded Dr. Carpenter for his paper.

British Foundrymen's Association: Birmingham Branch.

Visit to the Wolseley Motor Car Works.

The best attended and most successful visit yet undertaken by the Birmingham Branch of the British Foundrymen's Association was that which took place on Saturday, February 11, to the works of the Wolseley Tool and Motor-car Company, Limited, Adderley Park, Birmingham. Considerably over a hundred members met at the works and spent the afternoon in a tour of the various departments, paying special attention to the foundries and pattern shop. The machine shop was especially admired because of its remarkably complete equipment of up-to-date machines, including many automatic appliances of the latest type. Among the visitors were Messrs. F. J. Cook (ex-President of the Association), R. Mason (ex-President of the Branch), H. L. Reason (Vice-President), and G. Hailstone (hon. secretary). The visitors were divided into nine parties under the general direction of Mr. W. T. Costigan (superintendent of the wood and metal pattern departments), his colleagues being Messrs. Gower (foundry foreman and a member of the Association), Dipple, W. Stevens, Jones, Dawkins, Haddleton, Wattis, and Stally. The tour of the shops occupied nearly three hours, and every facility was afforded the visitors to inspect the details, especial pains being taken to explain the mechanical operations of motor and car construction.

The Wolseley Tool and Motor-car Company (which is a subsidiary company of Vickers, Sons & Maxim, Limited) was formed in February, 1901, for the purpose of acquiring and developing the manufacture of the Wolseley horizontal motor-car. The growth of the Wolseley business has more than kept pace with the development of the motor industry, and both may be typified by the contrast between the Wolseley motor-car made in 1895 by the Wolseley Sheep-shearing Machine Company, and the up-to-date cars which may be seen in the Wolseley show rooms to-day in London, Manchester, Birmingham, and other centres. The original Wolseley car was a light three-wheeled vehicle built on cycle lines and scarcely more imposing in appearance than a bath-chair, which it resembled in having a front steering wheel actuated by a tiller. It carried one passenger besides the driver, and was fitted with a 2-h.p. horizontal motor. Contrasted with this car, the original of which may still be seen in the yard at Adderley Park, are now to be seen such products as the great pleasure cars built at

FIG. 1.—IRON FOUNDRY; WORKS OF THE WOLSELEY TOOL AND MOTOR CAR COMPANY, LIMITED.

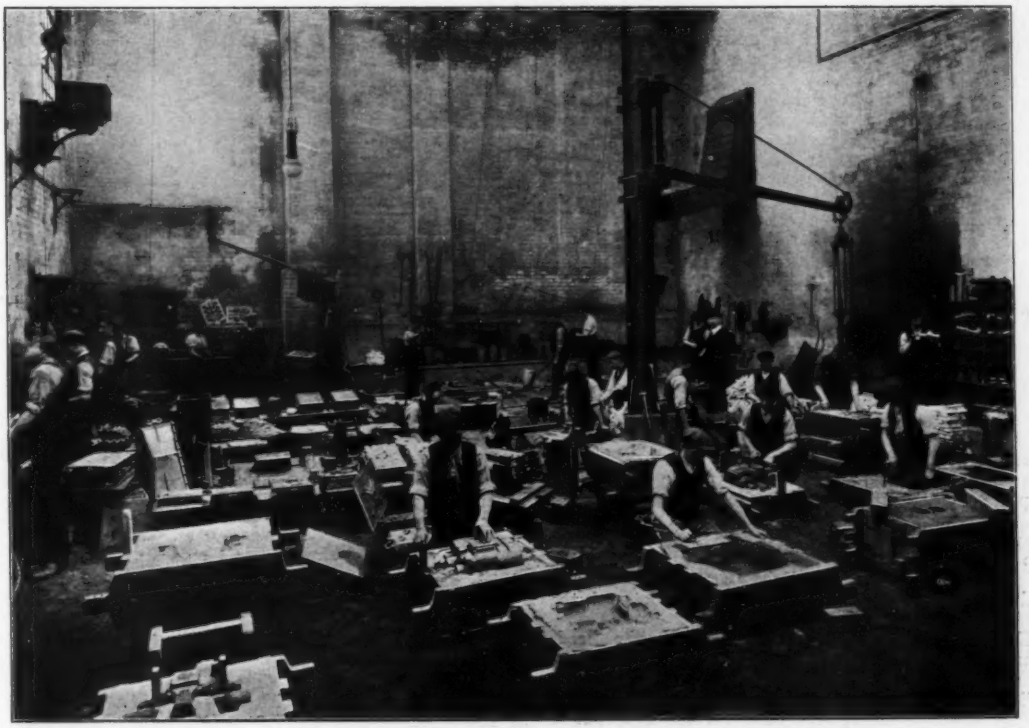


FIG. 2.—PART OF ALUMINIUM FOUNDRY; WORKS OF THE WOLSELEY TOOL & MOTOR CAR COMPANY, LIMITED.

FIG. 3.—PART OF NEW PATTERN SHOP; WORKS OF THE WOLSELEY TOOL & MOTOR CAR COMPANY, LIMITED.

Adderley Park, of which six principal models are now constructed, namely, 12-16 h.p., 16-20 h.p., 20-28 h.p., 24-30 h.p., 30-34 h.p. (which can also be fitted with 40 h.p. engine, if desired), and 50 h.p. The 24-30 h.p. and the 50 h.p. are six-cylinder cars, and the remainder are fitted with four-cylinder engines. To these cars every style of modern carriage body, from the finest-lined racing type to the most luxurious touring pattern may be adapted. The Company has also added the manufacture of marine engines for motor boats and submarines. One of the earliest of their marine engines was one of 60-horse-power for the Duke of Westminster. In July, 1907, the Company opened a branch at East Cowes, from which a number of motor boats have been turned out, the most successful of these being the "Ursula," the present holder of the motor-boat record for distances over one mile. With the advent of practical aviation, the Company commenced the manufacture of aero engines both for aeroplanes and for dirigibles. They have recently completed the engines for the naval dirigible balloon now under construction by Vickers, Sons & Maxim, Limited, at Barrow, for the British Government. Last year they turned out a fleet of motor sleighs for Captain Scott's Antarctic expedition, and the trials of this machine under practically Polar conditions proved so successful that three have been ordered for the rival German expedition. Engines for motor railway cars and electric lighting sets for factories and mansions are also among the products of the Company.

The works at Adderley Park forming the headquarters of the firm occupy a total area of about 23 acres, about 17 acres of which are covered with buildings, and from 3,500 to 4,000 hands are constantly employed. The works are divided by a public road into two sections, the East and the West Works, the latter containing along the main frontage the offices for the management, clerical and drawing office staffs, whilst at the rear are the foundry, the engine-erecting shop, and the machine shop. Some recent additions which adjoin these premises are the new assembling shop, stores, repair shop, an engine-erecting shop, engine-test shops, and a private test shop for experimental work. The resources of the works at Adderley Park, great as they are, have the advantage of being supplemented by those of their parent firm, Vickers, Sons & Maxim, Limited, and by the experience of that firm in the production of high-grade materials. Vickers' steels are almost exclusively employed, and the Wolseley Company can claim that all the component parts of its vehicles, with the exception of tyres, magnetos and accumulators, are made in its own workshops mainly from raw material of its own production.

The visitors, whilst their interest was naturally concentrated chiefly upon the foundry and its adjuncts, were scarcely less interested in the constructive and general departments of the works. They were particularly struck by the imposing interior of the principal machine shop. The shop measures 300 ft. by 200 ft., and is equipped with machinery of the latest type, to which additions are continually being made. Here are received, in addition to the castings from the foundry, the forgings from the smiths' shop and the stamping department. In fact, the whole of the parts which go to the making of the complete chassis may be said to come together for the first time here. Lathes and milling machines, drilling and boring machines of every variety for the turning out of finished parts in rapid succession were to be seen. From this machine department are turned out every week more than 120,000 parts. In this and all other departments requiring power the driving is electrical.

The tour included a visit to the inspection room, where working parts are gauged to limits, in some cases, finer than 1,000th of an inch; the engine erecting and testing shops, in the latter of which most exhaustive trials are conducted, and the department for assembling gears and components, where special precautions are taken to ensure both gears and axles being as nearly noiseless as possible; also a separate branch which is devoted to the assembling of the smaller parts, such as change speed gears, etc. In the chassis erecting-shop, the visitors had explained to them how all the parts are brought together into a complete chassis before being transferred to this department, where the frames to which springs have already been fitted are waiting to receive them. After being erected, the finished chassis are carefully inspected and are then turned over to be tested on the road. In the road-test department, which is one of the largest shops, was seen long ranks of cars and chassis which had received or were awaiting trial. After the tuning-up of the machinery the chassis has a temporary body fitted and undergoes a series of trial runs, not only on the splendid track which encircles one half of the works (and which has lately been asphalted), but also on the open roads. On being proved perfect throughout, the chassis, passing to the carriage section, enters the mounting department, where the carriage body, which has previously been built by their staff of coachbuilders in the body construction department, is fitted to it. After fitting, the car is taken apart and the chassis goes to the painting department, while the body goes through the processes of facing, trimming and varnishing. The body and chassis are then brought together again in the mounting and finishing department.

The works have excellent sidings connected with the London and North-Western Railway main line, and by this means many of the cars are despatched. Amongst the latest extensions of the works is a new set of mess-rooms for the workmen and staff. The building is also used for social gatherings, concerts, lectures, gymnastic contests, etc. The works also have a miniature rifle club and range, and football and cricket clubs. The office and administrative organisation is well up to date, among other arrangements being an hourly postal collection from every department.

The foundry department had for the visitors, of course, a special interest. The manufacture of the modern internal-combustion engine and its auxiliary parts, whether for motor-cars, marine service, submarine, flying machines, or dirigible balloons has called for castings of exceptionally thin, complicated, and compound sections of metal. Pattern-making, therefore, in a works of this character calls for special methods and the highest craftsmanship. On the amalgamation of Brown, Marshalls & Company, Limited, with the Metropolitan Railway Carriage and Wagon Company, the Wolseley Company purchased from the former a considerable area adjoining the Wolseley Works. Upon part of this the new pattern shop has been erected. Adjoining is a building which is about to be laid out as an aluminium foundry, and which will be one of the largest shops of the kind in the country, and will increase very considerably the present foundry capacity. To take charge of this new department, the firm have secured the services of Mr. W. A. Dawkins, whose Continental and other experience especially fits him for dealing with progressive foundry work.

The new pattern shop has a floor space of 120 ft. by 80 ft., divided into two bays. It is lofty and well-lighted, and is laid out with a completely modern equipment of machines and tools, including eight lathes, the usual power saws, sensitive drilling ma-

chines, and eight mounted cast-iron laying-off and setting-up tables grooved for centre poppets, with dividing heads, adjustable angle plates, V-blocks and sets of steel parallel strips and scribing blocks for each table. The pattern-makers are supplied with sets of steel contraction rules specially made, after careful tests, to suit the shrinkages for dry and green sand aluminium castings, cast and malleable iron, steel, gunmetal, phosphor bronze, etc. The department is laid out to deal with both wood and metal patterns for a large output of castings, including snap flask, plate and machine-moulding. The metal patterns are made from alloys of aluminium, brass and gunmetal, as the particular shape of the pattern and its adaptability to the moulding process demands. As was pointed out to the visitors, the requirements of the motor industry, in regard not only to varied construction, but also to lightness of parts, has called into existence special methods and a class of specially trained workmen of the highest skill. Great interest, therefore, was shown in the large and highly instructive display of jacketed cylinder, crank case, carburetter and other thin castings set out in the pattern shop, and cut through lengthwise and transversely so as to expose intricate sections of single and double jacket areas, and exhaust and induction pipes outside and between the central cores. This work especially was admitted to call for exceptionally skilled men.

It was explained that the selected boys for apprenticeship in the pattern shop are put on trial for a period, and are only indentured if they unmistakably show such aptness as proves that they are likely to succeed at the work. The apprentices are required to attend two classes per week (but not on consecutive evenings) at the Municipal Technical School. The classes at which attendance is compulsory are not necessarily on pattern-making. Apprentices are rather encouraged to take up machine-drawing and construction and such other subjects as will enable them to appreciate the practical requirements which pattern-making is to serve. The restriction to two class nights per week is meant to encourage the boys to go in for such healthy relaxation as gymnastics. It has been found that this system yields better results than an excessive number of class nights, which tends to the acquirement of a smattering of learning often at the expense of health and practical efficiency.

A part of the pattern shop is equipped with a moulding tub, moulding boxes, and foundry tools, and here the young apprentice receives his first practical lesson in moulding and is taught by experience the necessity for making patterns that will produce good moulds and for studying quick and clean delivery from the sand. This has been found to stimulate greatly the interest of the boys in their work and the desire of each to excel. Experience of the system has already proved that it yields a good commercial result to the employer and considerably enhances the position as a craftsman of the boy so trained.

The present foundry is somewhat distant from the new pattern shop, but the additional land recently acquired by the Company will enable it to perfect the grouping of its departments in due course, and when the new foundry is completed it will be so arranged that the raw material and fuel can be delivered to the spots at which they will be used. The main foundry is about 135 ft. by 60 ft. in two bays. It is served by a Thwaites' No. 5 cupola, melting about 5½ tons per day, and Thwaites' blowers supply the air pressure. Mr. Gower (the foundry manager) has under him about 100 men and boys in this foundry, which is devoted to brass and copper, and in the adjoining aluminium foundry. Among the metals from which castings are made are aluminium, iron, gunmetal, phosphor bronze and brass. It may be noted that the firm is making an increasing use of the new alloy, Duralumin, which, however, cannot be cast, but can be readily rolled, forged, stamped and drawn. It has a tensile strength of 35 tons, and the highest quality is equal in fracture to 40-ton steel, while the lowest quality is equal in all physical qualities to mild steel. Its density does not range higher than 2.85, and this comparative lightness, together with its physical qualities, makes it specially suitable for motor work. The firm now possesses, at Adderley Park, a fully equipped laboratory in which metallurgical analyses—formerly done at Vickers' Sheffield works—are constantly being made. Test bars are taken for all castings of whatever metal, and these are subjected to various physical tests.

At the conclusion of the tour round the works, the visitors were entertained to tea in the new mess room.

Mr. F. J. Cook, introducing Mr. R. Mason to propose a vote of thanks, said that such an acknowledgment was the least recognition they could make for the kindness of the Company in arranging for the visit.

Mr. R. Mason said the duty entrusted to him was a great pleasure. The Company could hardly hope for any return, seeing that foundrymen were not in the habit of purchasing motor-cars. The tour had afforded them great pleasure. From the past, they had found that every visit had furnished them with some suggestion of which they were able to make use in their daily work. In this visit they had noticed much that was new to them. To Mr. Costigan, who had organised the party, and his colleagues, who had given up their Saturday afternoon in their interest, they were specially indebted. They were under a great obligation also to the directorate and the management who had so generously shown them everything there was to see. Many firms did not give such a welcome to strangers. They were glad to see the signs of continuous and rapid growth, particularly the evidences of care taken for the health of the men and their protection against accident. They were glad also to see notices of lectures, which was another excellent sign of progress. He proposed that they heartily thank the management and the guides and all concerned for their kindness (Applause.)

Mr. H. L. Reason, seconding, the vote was carried with acclamation.

Mr. W. T. Costigan, responding, expressed his regret that the works manager, Mr. Lawrence, was not able to welcome the visitors. It had been a great pleasure to the Company to facilitate the visit, whilst the members of the staff, who were all extremely pleased to conduct them around, considered it was an investment in good-fellowship and good-feeling. Practical men knew the difficulties which frequently arose in grappling with casting problems, and that produced a reciprocal and appreciative understanding. They had not a large foundry, but he thought that if the visit had occurred a few months later the visitors would have been interested in the new foundry which would then be at work. The total number employed in the works was now nearly 4,000 men, and the present foundry was rather cramped for the provision of so much material. He trusted, however, that they had seen many things to interest them in car construction on an extensive scale. In conclusion, he thanked them on behalf of the firm, his colleagues, and himself, for their very kind acknowledgment and expressed the hope that they might meet on some future occasion.

Mr. Gower (the foundry foreman) also acknowledged the vote, and expressed his pleasure at seeing so many present.

The Application of the Microscope in Foundry Practice.

At a meeting of the Lancashire Branch of the British Foundrymen's Association, held at the School of Technology, Manchester, on Saturday, February 4, Mr. R. W. Kenyon (President of the Branch) in the chair, an illustrated lecture was given by Mr. G. Hailstone, of Birmingham, on "The Application of the Microscope to Foundry Practice." The President, in introducing the lecturer, said that Mr. Hailstone was well known to them as occupying an important professional position in Birmingham, and also as Honorary Secretary of the Birmingham Branch of the Association.

Mr. Hailstone's lecture was as follows:—

The microscopic examination of metals is not a very old science, and the pioneer of this branch of study was the late Dr. Sorby, of Sheffield, who, in 1864, pointed out the analogy which exists between the internal structure of metals and crystalline rocks when examined under the microscope, he having, in 1858, published some of his observations on the latter. For a long time Sorby's work lay dormant, and I have heard it stated how geologists ridiculed the idea of examining mountains under the microscope, and, therefore, metallurgical applications were ignored for quite a number of years.

When this method of studying rocks was taken up in earnest the progress was very rapid, as it was a comparatively easy matter to cut and grind sections of rocks down to a thin slice to be almost transparent, so that the examination could be made by transmitted light, but a metal section is opaque, and can therefore only be examined by reflected light. This deprives the metallurgist of some of the most valuable tests open to the petrographer.

There is no record of any work done with regard to metals until about 1878, when Martens, in Germany, published a paper also relating to the structure of iron and steel, but the extension of Sorby's pioneering work after that time is largely due to Arnold, Osmond, and Stead. Since then the number of investigators have increased enormously, and now no metallurgical research is complete unless a microscopical examination has been included.

It may be said by some that the microscopic examination of pig-iron is simply a more refined way of examining the fracture, but this is not so. A fracture reveals only the appearance after breaking by a force, such as a blow, and even the nature of the blow used to effect fracture has a considerable influence on the appearance of that fracture. In breaking a pig of iron the greater portion of the fracture follows the plates of graphite, and, as a result, the broken surface may show a preponderance of graphite inconsistent with the actual composition of the pig. The microscopical structure shows the actual relation that exists between the various constituents contained in the iron, and therefore may be termed the internal architecture.

Methods of Preparing and Examining.

The samples of pig- or cast-iron, as the case may be, are either cut in a saw or lathe, or by filing in a vice, or other means, according to circumstances, to a suitable size. A convenient-sized section is one about 0.5 in. diameter and 0.1 in. thick. The face of the section to be examined is filed flat with a dead-smooth file, and the edges slightly bevelled to prevent it injuring the polishing pads in the subsequent operations. When all the file marks are in the same direction the specimen is ready for the actual operation of polishing.

The polishing may be performed by hand or machine. The method of polishing by hand is as follows:—When all the file marks are running in the same direction the section is rubbed at right angles to the file marks on a piece of FF emery cloth that has been stretched upon a piece of smooth, hard wood, a convenient size being 12 in. by 3 in. by 1 in. Again, when all the marks made by the FF emery cloth are in the same direction, and the whole of the file marks have been removed, the section is reversed and rubbed on O emery cloth, and this process is continued on O, OO, OOO, and OOOO emery papers, reversing the section each time the paper is changed. The section of iron is then rubbed, at right angles to the scratches, on a piece of wash leather, covered with the finest rouge, stretched on

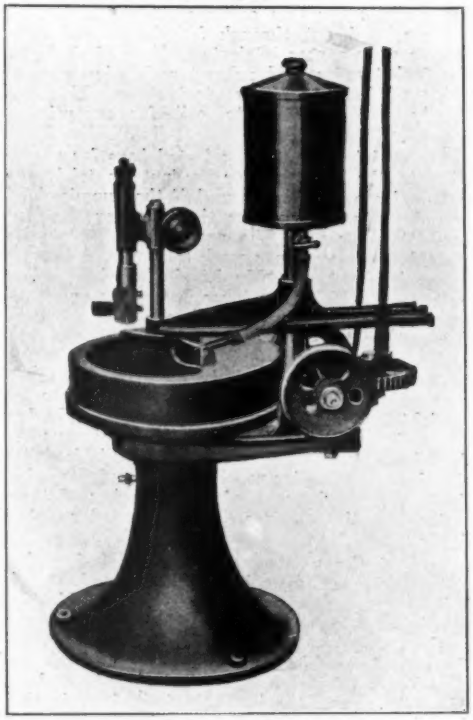


FIG 1. POLISHING MACHINE.

a piece of wood, until the section is free from scratches.

When the section is free from scratches it will be noticed that the surface is discoloured or tarnished, due to high local temperatures being produced between the metal and the polishing pad. To remove this colourisation, the specimen is rubbed a few times upon a rouged pad which is kept well moistoned by alcohol. The specimen is now wiped dry by means of a piece of old soft linen, after which it is ready to be examined to determine the size of the graphite, and then to be etched.

I will now describe to you a method of polishing by a machine made by Messrs. Carling & Son. The machine consists of a horizontal table which is made to revolve, on which is carried a conical block upon

which is stretched and held in position by means of a metal ring the necessary grade of polishing material and called the polishing bed. A vessel for holding either water or other solution is provided, with a tap for allowing the liquid to drop on to the prepared polishing bed. A vertical spindle worked by suitable mechanism oscillates across the face of the polishing bed; to this spindle is attached the machine head, and provision is made for coarse adjustment, to allow for any difference in thickness of polishing beds or sections. On the top of the head is a milled nut for regulating the pressure on the work. The lower end is arranged to take any of the chucks sent with the machine, in which the metal sections are held for polishing.

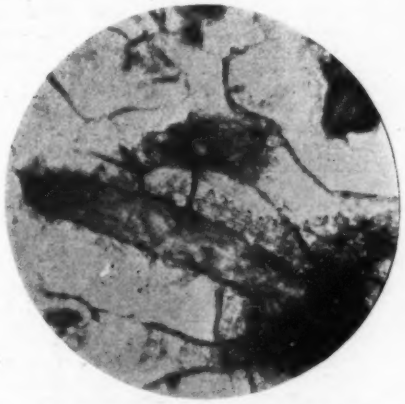


FIG. 2.—LARGE FLAKES OF GRAPHITE AND CRYSTALS OF FERRITE IN CAST IRON.

We will now suppose the section is in position on the machine. Starting with a bed of FF emery cloth, the machine is set in operation, which gives two motions, *viz.*, the circular bed revolving in a true plane upon its axis, and the oscillating head with its section attached passing over it, at a greater radius, and not concentric to the bed, but in the same true plane. When the file marks have disappeared, a second bed of O emery paper is used, then a third of OO emery, then a fourth of OOO emery, and following this one of OOOO emery, and the same operation repeated. The next bed consists of a piece of rouged wash leather stretched upon a conical block by means of a metal ring, and methylated spirit is allowed to drop from the vessel to keep the pad moist, when a good polish is produced in three or four minutes. From time to time during these operations the specimen should be examined. Ultimately the specimen is free from scratches. At this stage very little pressure is required on the specimen, and this is regulated by means of the milled nut on the top of the head. If the polishing is carried too far the fine surface is destroyed and it becomes uneven and dull. If the polishing has been stopped at the right moment, it is ready for examination and etching.

The Microscope.

There are several points in connection with the microscope to which it is desirable to call attention, also some special accessories used in examining metallic sections which it will be necessary to describe.

Any good miscroscope stand may be used, but it is desirable that it should be fitted with an inclining joint so that it may be used in both horizontal and vertical positions, it should have a rough adjustment, also a sensitive fine adjustment. The base should be sufficiently large and weighty to render the instrument perfectly rigid in both positions.

An instrument specially designed for the examination of metals possesses a stage upon which the specimen under observation may be moved backwards and forwards and from right to left by means of the milled-headed screws, which enable the observer to move the specimen gently and so examine the whole area of same.

Metallic specimens, being opaque, cannot be examined by transmitted light, consequently special illuminating apparatus has to be used. The illumination generally used in examining cast-iron is termed "Vertical illumination." This is produced by having a hole in the microscope tube, just above the objective, and a right-angled prism placed in it in such a position that it reflects any light which passes on to it, through the hole, down on to the section, which is then transmitted up the tube of the microscope.

A Welsbach gas-burner may be used as a source of illumination. Between the source of light and the prism illuminator a bull's-eye condenser should be placed to concentrate the rays.

Dr. J. E. Stead has recently designed a workshop microscope for the use in iron and steel foundries. The stand consists of a disc supported by three legs, the length of which can be adjusted by turning the milled screws. The lower terminals of the legs consist of hard steel points, and the upper ends are secured by screws into the brass disc. The microscope tube, 8 in. in length, is free to slide through a second tube secured in the centre of the disc, and, when in use, focus is obtained by moving the tube upwards and downwards by the fingers. When the focus is found the tube can be fixed, if desired, by a small set screw. The illumination is effected in a similar way as was before described, the source of light being obtained by means of an electric lamp fixed in the horizontal tube, the current being obtained from a pocket battery. With this instrument magnifications of from 20 to 50 diameters are obtained, such magnification being quite enough to enable the ironfounder to determine approximately what the proportion of phosphorus is in his castings,

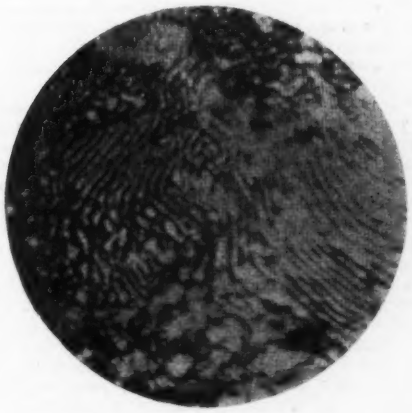


FIG. 3.—PEARLITE IN CAST IRON.

also whether the percentage of combined carbon is great or small. When it is desired to examine a finished casting the microscope is placed over the part the examination of which is required, which has previously been polished by rubbing with the different grades of emery paper, and the light is switched on. The sharp pointed legs of the stand when pressed on to the metal prevent the microscope from slipping. In this way either flat or curved surfaces can be readily examined.

It often happens that the sections of iron to be examined are not regular in shape, and the polished

FIG. 4.—I.X.L. PIG-IRON. ANALYSIS: G.C. 3.27; C.C. 0.05; SI. 3.25; S. 0.045; MN. 0.78; P. 0.40. THE STRUCTURE CONSISTS OF LARGE FLAKES OF GRAPHITE IN A MATRIX OF CRYSTALS OF FERRITE WHICH ALSO CONTAINS AREAS OF IRON PHOSPHITE.

surface is not parallel with the opposite sides. As the preparation of pieces of regular thickness involve the loss of time, as in the case of a piece of white iron, and also as it is generally only one flat surface that is required, it is necessary to mount the irregular shapes of metal on the glass microscopical slide so that the polished surface of the section is always parallel with that of the microscopic slide. The most convenient way to do this is to have a number of pieces of metal tube about 1 in. in diameter, cut off perfectly true about 0.25, 0.50, 0.75, and 1.00 in. long respectively. The metal section is placed face downwards upon the rouge pad, and the nearest-sized ring placed over it. A piece of plastic material, such as plasticine, is pressed upon the centre of a microscopic slide, to which it adheres. The slide is then turned down, and is pressed on to the back of the specimen until the glass rests upon the top of the metal ring; the slide is then removed with the section adhering to it, having its polished surface parallel with that of the slide. The whole of the operation of mounting in this way only takes a few seconds to complete. After examination the section of the metal may be removed most readily and further treated if necessary.

Etching.

After the polished section of cast-iron has been examined to determine the size of the graphite, it may be treated with suitable chemical re-agents to reveal the various constituents present. One of the most useful re-agents for this purpose is "tincture of iodine," as obtained from the pharmaceutical chemist. This solution is applied to the section by the successive touch of a drop conveyed by the finger, the drop of solution being allowed to remain on the specimen until it is completely decolourised, when it is examined, a further addition being added if needed. After etching the specimens are washed in alcohol and wiped with a piece of fine dry linen. Another re-agent I have found that gives good results with cast-iron is a 5 per cent. solution of sulphurous acid in water. The solution is placed in a small dish and the specimen immersed in the solution for a minute or so, this operation being repeated until the metal is sufficiently etched.

Constituents Revealed by Etching.

I will now describe the different constituents that occur in cast-iron, and show you how they appear when the section has been etched by means of "tincture of iodine." The micro-constituents that are usually found in normally-cooled commercial grey foundry irons are six in number, *viz.*, ferrite, cementite, pearlite, phosphide of iron, which when cementite is present forms an eutectic, and manganese sulphide. The formation and amount of these constituents, however, depend upon the amount of silicon, sulphur, phosphorus, manganese, and carbon the iron contains, as well as a great many other interfering factors, such as casting temperature and rate of cooling. We therefore get also in the iron, alloys of iron, sulphur, and silicon, pearlite containing phosphorus, manganese sulphide containing iron sulphide, and manganese silicate and cementite (supposed to

FIG. 5.—I.X.L. COLD BLAST PIG-IRON NO. 6 ANALYSIS: G.C. 2.25; C.C. 0.75; SI. 1.05; S. 0.10; P. 0.39; MN. 0.75. THE STRUCTURE OF THIS IRON CONSISTS OF SMALL FLAKES OF GRAPHITE IN A MATRIX OF PEARLITE, CONTAINING ALSO AN AREA OF THE IRON-CARBON-PHOSPHORUS EUTECTIC.

be a chemical compound containing silicon and manganese and sometimes phosphorus).

Ferrite is pure iron; sometimes it occurs in crystals that are readily recognised, but more often than not as a white groundwork or matrix. Being unstained by the etching liquid that is used to reveal the various constituents, it remains white. Silicon and manganese are present in the ferrite, and as they are isomorphous with the iron, they often replace some of the crystals of ferrite. Ferrite is the softest constituent of cast-iron, excepting graphite. Before leaving the constituent ferrite it may be interesting to consider how silicon affects the properties of the iron. Silicon exists in cast-iron as a silicide of iron,

but this silicide is in solution in the iron, forming crystals of the cubic system, which, as I have stated before, is isomorphous with pure iron, and can therefore replace it. On examining a section of slowly cooled iron containing 3 per cent. of silicon and only traces of the other elements (excepting carbon to about 3.5 per cent), I have seen crystals of this solid solution of silico-ferrite side by side with crystals of ferrite.

The crystals of silico-ferrite are of a pale yellow colour, and the ordinary ferrite white. Silicon may be said to act in three ways in cast-iron:—(1) By inducing the separation of graphite in large flakes; (2) by inducing the separation of graphite in very fine flakes; (3) by uniting with iron and manganese to form silicides, which tend to induce a large crystaline structure, and also increase the hardness and brittleness in proportion to the amount of silicon present.

Cementite is the carbide of iron containing 6.6 per cent. of carbon. It is a vexed question as to whether cementite is a chemical compound or not in foundry irons. It is most probble that in a pure iron-carbon alloy the pure carbide corresponding to the formula Fe_3C is present, and this has been separated from the main alloy by Professors Arnold and Read's method. However, with alloys or cast-irons containing phosphorus the carbide which is separated by the above method contains phosphorus. Now, if the carbide was a true chemical compound, I am inclined to think the carbide should separate pure, *i.e.*, should contain nothing else but iron and carbon. Whereas,

FIG. 6.—BESTWOOD SILICEOUS PIG-IRON. ANALSIS: G.C. 2.96; C.C. —; SI. 4.359; S. 0.030; P. 1.122; MN. 0.372. THE STRUCTURE OF THIS IRON CONSISTS OF LONG, THIN FLAKES OF GRAPHITE (A CHARACTERISTIC OF SILKY IRONS) IN A MATRIX OF SILICO-FERRITE, WHICH ALSO CONTAINS AREAS OF PHOSPHIDE OF IRON.

as stated before, some of the separated carbide contains an appreciable amount of phosphorus and silicon.

Sometimes the iron is replaced in cementite by manganese which itself forms a true chemical compound with carbon, when double carbides of iron and manganese result. Cementite is the hardest constituent of cast-iron. It resembles ferrite inasmuch as it is not stained by the etching liquid, but being very hard it stands up in relief after polishing, and is, therefore, readily distinguished.

Pearlite is a definite mixture of ferrite and cementite, containing about 0.89 per cent. of carbon. The carbon in pearlite is molecularly associated with only 12 per cent. of the iron, 87 per cent. of the latter being in the free state. Pearlite is recognised by its characteristic striated structure consisting of alternate laminæ of ferrite and cementite. It is coloured dark by the etching liquid, and when the specimen is a good one it has a very beautiful mother-of-pearl appearance, and is sometimes found granulated. As ferrite and cementite, when in segregated patches, are not coloured by the etching liquid, the question may be asked, how is it that pearlite is? The explanation of this is that on polishing as the cementite is the hardy constituent, the ferrite is rubbed away much more easily, and therefore, the cementite stands

FIG. 7.—SECTION OF CAST IRON STRONGLY ETCHED IN 20 PER CENT NITRIC ACID TO SHOW CONDITION OF THE PHOSPHORUS EUTECTIC (THE WHITE PORTION). THE NETWORK STRUCTURE IS CHARACTERISTIC OF ALL STRONG IRONS; WEAK IRONS DO NOT POSSESS THIS STRUCTURE.

up in relief. When the etching liquid is put upon the specimen some of it falls into the recesses formed by the rubbing away of the ferrite, and is not completely removed in the final polishing; also as cementite stands up above the ferrite, shadows are formed, and, therefore, we get this peculiar striated appearance.

Graphite is practically pure carbon in the free state; it occurs in cast-iron in varying-sized flakes, from very small to very large. The phosphorus compound associated with cementite, forms an entectic, and is characterised by the form it takes, like a number of streaks and dots. Thus phosphorus compound contains about 2 per cent. of carbon and 6.7 per cent. of phospherous. When present in cast-iron containing no cementite, the phospherous occurs as phosphide of iron, corresponding to the chemical formual, Fe_3P., and is a hard, white, structureless constituent similar to cementite, but softer.

Manganese sulphide occurs in square or oblong-shaped crystals of a dove-gray colour, when the manganese sulphide is pure, but often in cast-iron we find iron sulphide and manganese silicate have crystallised out in the crystals or areas of manganese sulphide, when we get light yellow crystals or deep blue coloured crystals respectively in the dove grey groundwork.

The manganese sulphide sometimes occurs in the cementite, and sometimes in the pearlite, according to the amount of sulphur present in the cast-iron.

In 1906 I made and published the following statements, *i.e.*:—"In making micrographic analyses of cast-iron, the writer has observed that when the sulphur in cast-iron has been below 0.11 per cent. the

manganese sulphide has always been found in the carbide of iron or cementite, but when the sulphur has been found to be above 0.11 per cent. ‚some manganese sulphide is found in the pearlite'.'

This points out that manganese sulphide appears to be soluble in cast-iron to a limited extent, and that 0.11 per cent. of sulphur in cast-iron containing manganese, which equals 0.3 per cent. of manganese sulphide, is the saturation limit of cast-iron for manganese sulphide.

To prepare and etch a specimen of cast-iron for the purpose of obtaining the condition and approximate amount of phosphorus present in the specimen, it is not necessary to highly polish the metal surface in this case. After polishing on fine emery paper the specimen is immersed in a 20 per cent. solution of nitric acid in water for two or three minutes, then washed with water and dried, when it can at once be examined.

Etching polished sections of cast-iron with chemical re-agents is more or less liable to lead to the confusing of the constitutional and crystalline structures. With very feeble etching, as a rule, the different constituents are made visible; with long continued etching the granular and crystalline structures are developed.

By heating polished and unetched sections of cast-iron till they assume certain oxidation tints, the various constituents are coloured differently. This colouring is due to the formation of oxidation films, which form at different rates on the different constituents. Heat-tinting does not usually give any indication of the crystalline structure, but stands far before all other methods as a means of detecting the individual constituents. It has a great advantage of not removing any of the metal, so that when the oxidation colour has been effected the original flat surface remains. The surfaces of the metal to be heat-tinted need special preparation. If after leaving the rouge pad they are at once heated until the tints appear, they will not be true, as the moisture in the porosities, when it evaporates, will affect the surface. It is necessary to make a preliminary heating to about 120 degrees C., remove from source of heat, and rub it whilst still hot on a clean rouge pad. It is then at once heated on sand bath until the proper tint has developed, when it is quenched in a bath of mercury to cool it rapidly and avoid further change.

When a section of cast-iron is treated in this way and heated until it becomes purple in colour to the naked eye, when examined under the microscope it will be seen that the various constituents are diversely coloured, the ferrite being a fine sky blue, the carbides of iron an orange colour, the phosphides a pale lemon yellow, and the sulphides a slaty blue.

Discussion.

Mr. W. J. Foster (Darlaston) said that the Paper was a very interesting one, but he thought that the lecturer had not gone quite far enough into the chemical compounds question. He himself had found in his experiments that the hotter the iron was the more carbon would it absorb, and he was convinced that any solution of carbon in iron other than cementite did not exist as a chemical compound. Cast-iron was simply a solution of carbon in iron, and not a chemical compound. In fact, the principles of chemistry proved that such a compound could not exist.

Mr. Cordingley asked whether the specimens dealt with in the lecture had been polished by hand or by machine. He strongly believed in microscopical testing for foundry work. He also asked Mr. Hailstone to explain why the high phosphorus iron mentioned in the Paper, containing 1.2 per cent. phosphrous, gave such a high deflection, namely half an inch? He would like to know, too, which produced the hardest iron, sulphur or manganese? Perhaps Mr. Hailstone would tell them definitely whether manganese sulphide was a chemical compound or not, and would also explain why silicon made iron hard, as he (Mr. Cordingley) had always believed that it made iron soft.

Mr. T. W. Markland (Bolton), referring to the polishing of specimens, said that he had never been able to obtain OOOO emery paper, and he would be glad to know where it could be procured. He had examined a number of specimens of cast-iron, but had found with his microscope that when a part of the section was in focus, another part was out of focus. He had also found great difficulty in taking photographs at high powers.

Mr. Hailstone, in reply, thanked Mr. Foster for his kind remarks, but said that, at present, he could not wholly agree with Mr. Foster's statements. He was glad to hear that the Stead microscope had been found beneficial by Mr. Cordingley, and he would add that all the micrographs which he had exhibited had been polish by hand. (Applause.) With regard to cast-iron, he did not think polishing by machines was at all suitable. The reason why the high deflection referred to by Mr. Cordingley was got with fairly high phosphorus iron was that irons possessing certain physical qualities had been mixed together. With regard to the question of hardness, it should be borne in mind that a very small percentage of sulphur counteracted a much larger percentage of manganese, and, therefore, sulphur made iron more hard than manganese did It also gave the iron better wearing properties. Manganese sulphide did exist as a true chemical compound, but in commercial cast-iron, as stated in his Paper, it was mixed with manganese silicate and iron sulphide. Manganese was very rarely found pure in cast-iron. Hulbert's OOOO emery paper might be obtained from Samuel Thornley & Sons, chemists, Snow Hill, Birmingham. In reply to Mr. Marshall's other question, he would suggest the reason why part of the section was out of focus, while the other was in, was either that the face of the specimen or the stage of the miroscope was not perfectly horizontal, or that the objectives and eye pieces were badly mounted. He quite appreciated the difficulty experienced in taking high power micrographs up to 1,000 diameters. This could not be done with any great result without using a very expensive micrographic apparatus and illumination by means of the electric arc.

On the motion of the President, a vote of thanks to Mr. Hailstone for his lecture was carried by acclamation.

The Council of the Staffordshire Iron and Steel Institute, acting on the suggestion of Mr. Moses Millard, are endeavouring to collect information relating to processes of iron making which have been practised in the Staffordshire district during the past 50 or 60 years, and wish also to gather the experience and reminiscences of the elder members, and others who may be disposed to contribute information. It is intended to publish the information so obtained.

In connection with the Home Office circular letter of the 13th May last, convening a special report on dangerous processes in the smelting of materials containing lead and in the manufacture of red and orange lead and of flaked litharge, we are informed that the Home Secretary has carefully considered the observations received in reply to that circular. The Secretary of State has now caused a draft of regulations for those processes to be prepared in pursuance of Section 79 of the Factory and Workshop Act, 1901.

Repairing Moulding Flasks and Boxes.

By M. J. P.

It is very often a matter ot debate in the mind of a foreman as to whether it would be better to destroy and replace a flask or to repair the same. The particular circumstances of the case at issue, such as expediency, extent of damage, etc., however, ultimately decide which should be done. In the matter of flasks, as in everything else, prevention is better than cure, and in foundries where the design and composition of the iron used in the flask are not carefully considered, much unnecessary loss is engendered.

Briefly, as to design, the flasks commonly used are either in plan circular, square, rectangular or some other plain figure with five or more sides. All of these except the first (circular) have corners of angles varying with the shape of the box part, which corners are clearly points of weakness inevitable to the case. The superior life of the circular flask with separate bars has been repeatedly demonstrated in actual practice, and will be generally admitted. Its economical

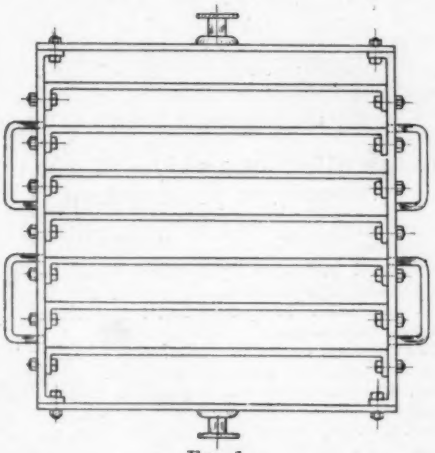


Fig. 1.

use, of course, is restricted to circular work. Corners are, therefore, unavoidable and design offers little scope for prevention of breakages at these points; the corners should, however, always be "bracketed."

Composition of the iron mixture used offers considerable scope for improvement, and it is here where the indiscriminating founder suffers much avoidable loss. It is a mistake to assume that any mixture that will run into an open sand mould will serve as a mixture for casting moulding boxes; it will not. It is false economy to use the cheapest iron with a maximum of scrap for this purpose. It may appear absurd to the untechnical man that he requires better iron for good durable flasks then he requires for general machinery castings, but he will undoubtedly find that a little money spent in the adoption, for this work, of a good brand of hematite iron, with steel scrap added as a strengthener, in quantities to suit the brand, will result in a saving even over a short period. Ten to 15 per cent. of low-phosphorus mild steel or wrought-iron scrap has been found to give good results. The necessity for good iron in moulding boxes is evident when it is considered to what rough usage they are for many purposes subjected; this applies especially to steel foundry practice, where hollow castings of complicated design, requiring "easing" and rapid removal are manufactured. In one instance within the writer's experience in steel foundry work, the matter of durable boxes was found to be so important that small and medium-sized box parts were cast in converter steel in green open-sand moulds and

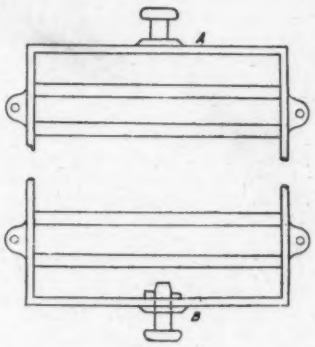


Fig. 2.

were found to be practically unbreakable under the former destructive conditions. This is not the general practice, but for special purposes could with great advantage be adopted.

Repairing.

The practice of "shelving" defective flasks is undoubtedly slipshod and very bad, for, if a flask is worth repairing at all, it should be repaired at once, and much delay will be avoided by keeping a stock of mild steel plates and angles or "bends" ready cut to lengths and drilled to suit the various flasks catalogued. By this means, and the intelligent use of a portable drill, a box can be repaired "on the spot" in a few minutes and work greatly facilitated.

In foundries where heavy work is done and boxes of the larger type used, say, of from 5 to 15 ft., and

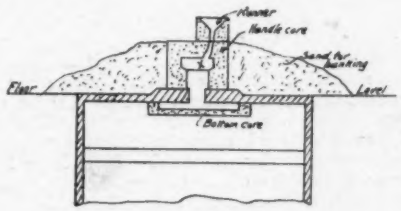


Fig. 3.

of any depth, the question of repairing becomes a more serious one, as the larger box is necessarily more expensive and a smaller number are kept, the largest size box probably only being used on rare occasions. No up-to-date foundryman now makes flasks of over 6 ft. square in one piece, but casts them in sections and builds them up. In this way it is easy to replace a broken end, rib, or side, which spare parts should always be kept in stock to avoid delay.

Bolt holes of sizes varying with the strength required, but standard for all parts of the same size, are cast into the flanges. These boxes are, of course, more expensive to make, but no skilled labour is needed to fit them together; the "handy man" will always be found capable of doing this. Besides being quickly repaired, these boxes can be increased or decreased in size at will within limits, by putting in or taking out the flanged sections, as will be seen by an examination of Fig. 1.

Apart from rough usage, many broken boxes result from wrong methods of hinging. There are few old hands but have cause to know that a large mould, closed, properly stayed and weighted, will often cast successfully when the same mould badly slung may become utterly wrecked in manipulation; especially when the box has seen much service and suffered somewhat from corrosion by exposure, or contains a hidden flaw or blow hole in a vital part (the result of using bad, cheap iron in the casting of the flask itself).

The larger and heavier a flask, the more important the question of the disposition of the handles and the method of slinging becomes; for instance, the limitation of end slinging is just as easily demonstrable by the laws of stress and strain as the danger limit of a beam, and many boxes are designed with end handles for convenience of manipulation when empty, that are totally incapable of sustaining the combined weight of the entire job. Taking a box of the type described, of say, 12 ft. length, it would be obviously faulty practice to use the end handles for manipulating a heavy mould fully rammed. Handles are always fixed on the sides of such boxes, the number increasing with the length of the sides. A box of 6 ft. should have no less than two handles of the loop type on either side, either cast on massive or of wrought iron cast in, the latter for preference, as shown in the illustration. The side and end sections are perforated by casting in holes of about ¾ in. round.

One of the most common cases of breakage met with is perhaps that of a flask otherwise sound, but minus a handle or "snug." The flask in question probably belongs to that class which is too heavy to manipulate by hand, and too light to justify the casting in of wrought metal "snugs," as in the case of boxes of the heavier type. Such a box is shown at A Fig. 2. Early trouble in this direction led to the practice of casting a hole in the end of the box where the handle comes, and the subsequent fitting in of a wrought metal handle secured inside with a cotter as shown at B Fig. 2. This method, while giving a handle interchangeable and practically unbreakable, is expensive; it is also antiquated, and not to be recommended.

The best method is undoubtedly that of ramming up a wrought iron handle or trunnion in a core, and casting on to a "roggled" portion of it, projecting into the flask mould; the portion of the flash where the handle comes being swollen or thickened to allow of a good grip. This is probably the most common method, and should be adopted for all medium-sized boxes.

The writer was, on one occasion, called upon to deal with a number of boxes made with cast-on snugs, of the type shown in A Fig. 2; the iron was inferior and incapable of withstanding the rough usage to which they had been subjected. Having a steel plant at his disposal, and not wishing to condemn the lot, the following novel method was adopted of replacing the broken handles in cast mild steel. The handles were all broken at a point flush with the boss on the end of the box. The box-part was sunk into the floor with the broken end upwards, after passing a 1½-in. drill through the boss at the point of fracture. The hole was then surmounted by a two-part core exactly similar to the one used in the moulding of the original handle except that a runner was cut into it for the pouring of the steel. The hole drilled in the flask was made slightly less than the diameter of the handle stem, thus presenting a small rim of cast iron to be burnt by the molten steel. On the underside of the box end was placed another core forming a receptacle for the steel which on setting formed the inner end of the steel handle, and was about 6 in. by 4 in. by 1 in. On the steel being poured slowly from a shank, fusion took place. The small quantity of carbon necessarily taken up in fusion was negligible, the steel remaining quite malleable.

The small shrinkage hole which, in cases such as the foregoing, develops at x Fig. 3, can be avoided by the usual means if desired, but in the present case was ignored. To make fusion doubly sure the box part at the point where fusion is required can be heated with a gas or oil flame, though generally the high fluid temperature of the steel renders this unnecessary. Previous heating would, however, tend to reduce the possibility of the cracking of the cast-iron box part, which is liable to occur owing to the high unequal temperature produced at the parts adjacent to the hole. Baring and quick cooling of the cast-steel snug, immediately after casting, will also help to obviate cracking. A small overflow can be used if desired, but it will generally be found that this is unnecessary. Handles cast on in this way to boxes otherwise disabled have been in use for more than three years. The boxes operated upon were generally cope parts of about 3 ft. square.

The Installation and Use of Abrasive Wheels in Foundries.*

By Charles G. Smith.

The first thing necessary in the successful adoption of a grinding equipment of any size is the disposition of the installation to operate under conditions to produce practical results.

The method of controlling the factor of safety to the operator should be determined; whether by safety collars, which are tapered if possible on the concave side ¾ in. to the foot, so that the wheels may be tapered convexly accordingly (in this case, where the nature of the work will permit, the maximum amount of wheel exposed beyond the edge or rim of these collars should be 2 in. and the collars changed as the wheels wear), or by use of substantial hoods in cases where it is necessary to use wheels with straight sides, owing to the nature of work to be ground, or by using both hoods and collars.

Where possible, the general results will be more satisfactory where the safety collars are used; and should a wheel break in service, these collars (which should be at least ¾ in. thick and made from steel castings for wheels 24 in. in diameter) will hold the pieces together.

It is necessary to have machines solidly set on good foundations with a heavy spindle in long bearings that can be kept well lubricated, having all vibration eliminated, when carrying the load of the wheels with the additional weight of the heaviest safety collars that are to be used with them. For a 24 by 2 in. wheel with these safety collars the spindle should be at least 2¾ in. between the flanges where the wheel is mounted and for 24 in. wheels heavier than this, the spindle should be at least 2½ in. diameter with bearings not less than 12 in. long. This applies to

* From a Paper read before the Pittsburg Foundrymen's Association.

floor stands for foundry practice, especially where the work is of the heavier nature.

Machines for Steel Foundries.

In all steel foundries, excepting crucible plants where nothing but very small castings are made, and many malleable iron foundries where there is sufficient work of a heavy nature, the most economical machines that can be installed are swing frame grinders, and great care should be had in the installation of these machines, as the writer has seen many of them installed that did not produce practical results because of the installation of a machine entirely too light and without sufficient power and not run under proper speed conditions. These machines should be driven with flat belts, having a spindle at least 2 in. in diameter where the wheel is mounted, and carrying an 18, 20 or 24 in. wheel, and the wheel spindle driven by at least a 4 in. double belt. These machines have not proved economical in iron foundries.

Power for Driving.

There should be ample power driving the machine to keep the wheel operating under the proper speed while it is at its highest pressure of service. On the floor stand operating two 24 in. wheels, where two strong men are working, there should be at least 10 h.p., and on a swing frame grinder operating one 20 in. wheel of 2 or 2½ in. face, if driven by belt power, the countershaft should be driven by a 6 in. belt, as there are many cases in the foundries where the driving belt from the line shaft to the countershaft is comparatively short to enable the wheel arm to project under the crane, so as to make possible the placing of castings by the crane under the wheel.

In operating one of these machines with a motor connected to the countershaft, which must drive the belts and absorb the friction necessary, not less than a 7½ h.p. motor should be used, preferably a 10 h.p., but where the motor is mounted on a bracket at the elbow of this machine, the belt being connected directly from the motor pulley to the pulley on the wheel head, a 7½ h.p. motor is ample, and in some cases 5 h.p. has proved entirely satisfactory, in which cases an alternating current motor has been used. This will enable the operator to remove fins, gates and pads very rapidly, and the stronger the man the faster his record.

Safety Collars.

The adoption of safety collars has brought about this economical condition more than any other factor, in that it has enabled the adoption of speeds which bring results with safety. The practical safe limit for running abrasive wheels with straight sides is 5,000 ft. per minute peripheral speed, and even then it is quite hazardous, and unless these wheels are carefully protected with hoods it is really criminal for anyone who is operating either a large or fair sized grinding equipment to attempt the adoption of wheels with straight sides. With the safety collars properly used, it is more safe to operate at 6,500 ft. per minute than to operate the straight wheels at 5,000 ft., with the additional advantage that the same wheel on the same material will produce practically 170 per cent. in general results of what can be secured from the same wheel at 5,000 ft.

Anyone operating in accordance with all of the above stipulations will secure the highest degree of efficiency obtainable in foundry work, and the writer's experience has been that 6,500 ft. has proved to be the most economical speed at which to run. As this speed is approached, the conditions improve, and so far as it is surpassed conditions appear to retard, and this speed is also very safe, as the percentage of wheels that break which are made by the manufacturers of good wheels is very small.

Cup Wheels.

The use of cup wheels, or, as sometimes called, tub wheels, should at all times be avoided, as this is the most dangerous practice in the abrasive line, and in their stead, where it is necessary to do face grinding, a good substantial chuck should be used, with a cylinder wheel which has no back. It is apparent that with a cup or tub wheel which, for instance, may be 12 in. in diameter, 6 in. high, with a 2 in. or more thickness of rim, and a back 1 or 1½ in. thick, the centrifugal strain of this heavy rim pulling on this much lighter binding point, which is but 1½ in. thick at the spindle, compels the running of these wheels very slowly to keep within any reasonable lines of safety whatever; whereas, were this wheel made without the back and the cylinder completely surrounded with an adjustable chuck, whereby the wheel could be fed forward as worn, a higher speed could be maintained with perfect safety. A cup wheel should not be run more than 3,500 ft. or 3,800 ft. per minute, depending on the thickness of the rim, whereas a ring wheel may be run approximately 5,000 ft. per minute.

Natural and Artificial Abrasives.

Open-hearth converter, manganese and crucible steel castings, as well as other forms of steel products, such as forgings, etc., also malleable iron, after it has been annealed, are ground much faster and more economically with the natural abrasives, either in the emery or corundum or a combination of the two in various percentages, and it is necessary to be thoroughly acquainted with the local conditions, such as the percentages of carbon, manganese, etc., and the general conditions under which the wheels run, in order to secure the proper wheel in the necessary proportions and sizes of the abrasive grain, and their relative proportions to the ingredients of the bond, as there are many factors to be considered in determining this point.

Grey iron castings, also those made in hard white iron, before annealing, and from brass, may be ground to better advantage by the artificial abrasives, principally carborundum. There are cases in chilled work where both alundum and carborundum have given very satisfactory results, and in some cases in castings such as stove plate, the adamite, also adamite mixed with corundum, have proved very satisfactory, and in such cases as the grinding of manganese, safe and vault doors, and door frames, where the work is operated purely by machine feeding, the alundum appears to have given better service up to date.

Depreciation in Manufacturing Plants.

The following interesting particulars of the average depreciation in manufacturing plants are taken from a recent issue of "Technik und Wirtschaft," and refer on the one hand to plants operating by day only (column A), and on the other hand to plants operating by day and night (column B):—

	A. Per cent.	B. Per cent.
Buildings	3 to 5	3 to 5
Steam Boilers	5 to 10	7½ to 12
Steam Engines	4 to 10	5 to 12½
Gas Engines and Motors	8 to 12	12 to 15
Turbines, etc.	6 to 8	10 to 15
Gears	5 to 10	7 to 12
Heating Plants	4 to 10	6 to 10
Electric Lighting Apparatus	8 to 12	
Mines and Smelting Works	—	10 to 20
Construction (Iron and Steel)	5 to 12	7 to 12
Branch Railway Lines (including locomotives)	4 to 20	
Railways (Private Lines)	5 to 10	
Cranes, Hoists, and Elevators	7 to 10	10 to 15

The Installation and Equipment of a Small Brass Foundry.

By A. Napier.

In considering the installation of a plant for producing castings of brass, bronze and other non-ferrous alloys the requirements are somewhat different to those when iron is the metal to be handled. In the first place, the furnace used for brass and similar alloys is usually that employing the crucible in some form and burning coke or oil, or a hearth furnace burning coal, and melting in a fixed furnace sole. Numerous designs are employed but the cupola does not enter into the brass foundry. Another feature of difference is that the size of work turned out is, on the whole, much smaller than the average product of the iron foundry, and this means a difference in the equipment of the moulding shop, the majority of the articles moulded being small enough for handling on the bench.

A small brass foundry can be fitted out at a very small cost, especially when installed as an adjunct to an iron foundry, as the equipment of the latter will go a long way to meet the requirements of the brass moulding shop. But it is advisable to consider the brass foundry as independent of an iron foundry. A small brass foundry as an adjunct to an iron foundry may be fitted up in a corner of the building by installing a couple of crucible furnaces, accommodation for sand and fuel, a few moulding boxes and a moulding tub. A few other accessories complete the equipment for turning out the odd jobbing work which such a foundry would handle. But there is a vast difference between such a foundry and one built and equipped for the production of first-class brass and bronze castings. The latter shop may not be necessarily of very extensive proportions, but it will be fitted out with as much care and attention to details, and the proper sequence of operations, as an iron foundry would be.

Lay-Out.

In considering the lay-out of a brass foundry there are several features of importance; and though they may not so materially affect the working of the plant as in the cases of an iron foundry, the convenience of the foundryman is always a matter of importance if economy in production is aimed at. The departments to be housed in the foundry building are as follows:—The furnace or melting department, the moulding benches and moulding machines, the core-maker's bench, sand stores, metal stores, cleaning and dressing department. These should be disposed so that all unnecessary handling of moulds, cores, castings and materials is avoided, the operations following in sequence without hampering each other. As a typical outlay for a brass foundry may be given that shown in the accompanying sketch, Fig. 1. The track running through the centre of the building would allow of metal, sand, moulds, etc., being rapidly handled on trucks or trolleys.

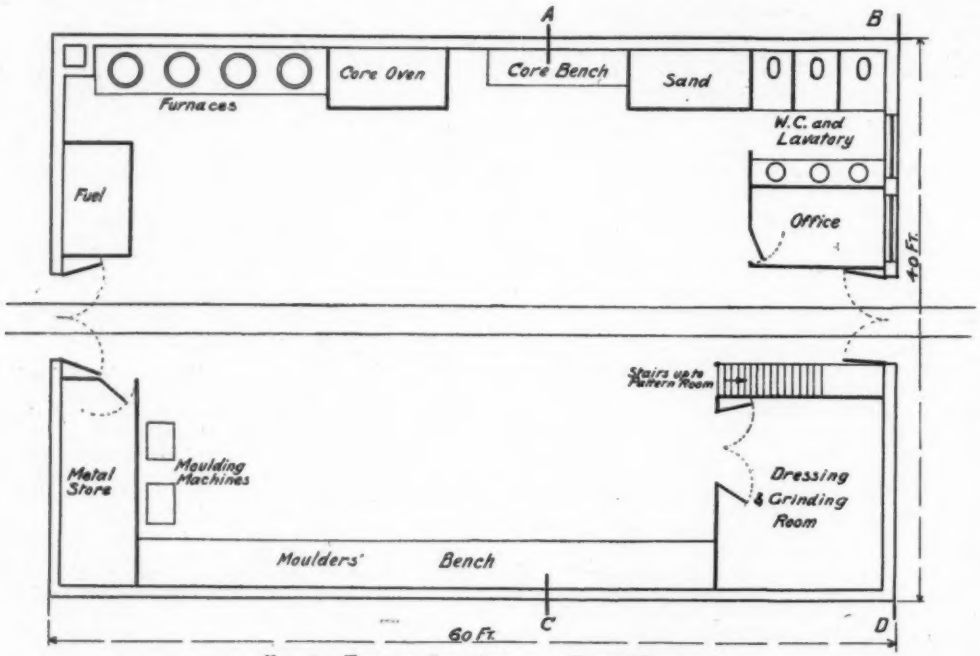


FIG. 1.—TYPICAL LAY-OUT OF A BRASS FOUNDRY.

An overhead travelling crane should, if possible, be installed, particularly if the melts are of considerable size, and would be preferable to jib cranes. But

probably one of the best systems for transporting and handling material, particularly where it is not desired to occupy space on the floor with trolleys or trucks, is that employing overhead trolleys on telpher rails. By such a system the whole of the floor may be conveniently covered, and anything of any material weight—sand, moulds, molten metal, cores, or finished castings—may be carried to any convenient position. The power employed may be hand, mechanical or electrical, as found most convenient.

As regards the arrangement of the building, the space A, B, C, D, in Fig. 1, might be covered by a second floor giving a room above for pattern storage and pattern work, and would keep this department out of the way of the moulding operations. Any machinery installed in the pattern shop could then be run from the same source of power as that employed for driving the machinery in the cleaning and grinding room below.

The possibility of future extensions must be kept in mind in arranging the plant; and though this may often be restricted or governed by the land and buildings available, much can generally be done in the early days of an installation to make extensions more readily carried out. A lantern-light or other roof-light over the remaining portion of the building would give a well lighted shop, in conjunction with the side windows. The necessity of a well-lighted shop for all foundry operations must be insisted on, though many of the foundries in this country are very badly lighted.

According to the class of work being handled, more or fewer moulding machines would be installed. In some cases the majority of the moulds can be made on machines, and in such cases a row of these could be ranged down near the centre of the building. When, however, much floor space is required for large moulds, the machines are best disposed nearer the walls, leaving the centre as clear as possible.

Attention might be drawn to the provision for a suitable lavatory, fitted with a sufficiency of washing basins supplied, if possible, with hot water, for the men to wash before meals and prior to leaving the works. This is not merely the suggestion of a faddist, but a really desirable feature in a foundry, for it has been conclusively proved that better work is turned out by the men whose comfort is attended to than where they have to retain all the grime of the many dirty operations of the foundry all through the meal times and until they are away from their work.

The Selection of the Furnace.

At the outset it is essential to thoroughly consider the various classes of furnaces available for brass melting, so that the class of work to be produced may be turned out economically, and the local conditions may be properly met. It may be stated as a fairly sound fact, that the value of one or other of the styles of furnace and systems of firing available to a foundryman depends more on the circumstances of the situation and on the acquaintance of the melter with the particular system being used, than on the actual efficiency under proper and suitable conditions. A man accustomed to melting with coke might, quite conceivably, find himself a little at a loss to as accurately gauge the working of a gas or oil furnace; and this undoubtedly accounts for a good deal of the prejudice with which the more modern systems have been regarded. The coke pit has the advantage of being in its essentials a somewhat primitive furnace, and it can therefore be more readily constructed where the more highly mechanical systems would be at a discount by reason of expenditure or materials available. That it can be made to operate successfully cannot be denied, or it would not have held the field so long. But it cannot be claimed for the coke pit that it is an ideal furnace, even in its best and most efficient form, for it does not utilise more than a small proportion of the heat generated from the fuel. This same objection, however, may be levelled at both the gas-fired and oil-fired furnaces, though their relative efficiency as regards fuel consumption is a matter open to debate.

Since good results may be got from either system of firing when worked carefully, the question resolves itself into rather one of capital outlay, available power and fuel supply, and generally the circumstance, under which the foundry has to be operated. It would be wrong to dogmatise on the question, as it is a matter to be settled by the judgment of the person laying down the plant. For small work the coke-pit crucible furnace often proves the most suitable; where a large class of work is to be done, or where the moulds vary considerably from a few ounces to several hundred pounds, one of the patent tilting oil or coke-fired furnaces generally prove more advantageous, as a larger heat is melted than in any single crucible, and the molten metal can be poured in larger quantities without first transferring it from the small crucibles to a larger mixer or ladle. Where the class of work frequently runs in weight to as much as two or three tons, a reverberatory furnace should be installed, so that a large heat of metal can be melted at once, and the composition assured with more certainty than if the metal from a large number of crucibles were melted and then mixed.

Coke-Pit Crucible Furnaces.

The first essential when installing coke-fired crucible furnaces is to so locate them that the flues can be connected with an outside chimney or stack, and for this reason they are generally placed alongside a wall. The ashpit may be either inside or outside the shop walls, according to convenience. If inside, the pit is usually covered with gratings, the opening being level with the floor of the shop; but in some instances a grated front for the admission of air is constructed, when the furnace is built above the level of the floor. For convenience and ease of access the furnaces are occasionally placed in the centre of the foundry building, but the simpler way is to place them near a wall, for the reasons mentioned.

A simple brass melting furnace may be constructed as follows :—A sheet iron shell is lined with fire brick, and rests on a bed plate. A cast-iron cover, usually lined with fire-brick, closes the top, and loose grate bars are supported on two bearing bars. A space below the bars about 12 to 18 in. deep, forms the ashpit, and the flue provided with a damper leads from near the top of the furnace to the chimney. In some foundries where economy is studied a common flue is provided for the range of furnaces and the waste heat conducted under a core or crucible store, in order to utilise the heat that would otherwise pass up the chimney. The coping plate of the furnace should be of cast-iron, about 2 in. thick, or a heavy wrought plate, the former being the most convenient to produce in a foundry. The covers, though generally of cast-iron lined with fire-brick, may be fire-clay tiles 4 in. thick, bound with wrought iron.

The diameter of the flue from the furnace should be at least one-third of that of the furnace grate, while one-sixth of the grate area may be taken as sufficient. The chimney should be no smaller than the flue, and preferably larger. When dampers are introduced into the chimney they should be so arranged as to leave the chimney unobstructed when fully open. Where a battery or row

of furnaces is installed and the flues all lead to one main flue connecting with the chimney, the main flue should have an area at least as great as the combined area of the furnace flues discharging into it, or the draught will be restricted and melting will probably be too slow. If a soft coke is used it is often advisable to construct a space in the chimney below the level of the flue, as is shown in Fig. 2, so that any accumulation of soot and dirt may collect there and be removed through a soot door provided for that purpose. But these arrangements are not necessary when a hard coke is used, as soot is then rarely made.

The pit in which the furnace is built should be sufficiently large to allow easy access for clearing the ashes, etc., a depth of about 6 ft. and width of from 6 to 7 ft. being a suitable size, from 12 to 18 in. being allowed below the grate bars, to permit access of a good air supply to the grate. The pit should be bricked round, and the floor be made hard and clean, and pillars to carry the furnace should be built as shown in Fig. 2 (cast-iron columns may be used if desired). On the bed plate the furnace is constructed, and bearers are built in as shown, to carry the grate bars. These latter may be plain, straight

The furnace interior may be either square or cylindrical, and while the latter gives some saving in the consumption of coke, the former is often preferred, as the square corners allow the tongs to be easily inserted for withdrawing the crucible, while with the latter there is a tendency to crush the crucible in forcing the tongs down to withdraw it. As regards the lining of the furnace, this may be rammed up with gannister 4 in. thick, which method obviates the pulling out of the fire-brick lining and rebuilding. Repairs can be made by daubing up with gannister when necessary. In some cases the lower half of the furnace is made up with gannister, and the upper half with fire-bricks.

Tilting Furnaces.

An important rival to the coke-pit furnace is the tilting furnace, of which several excellent designs are on the market. These are made in all sizes to take charges up to several hundredweight. Each furnace is built to take a particular size of crucible, and the fuel area is arranged to economically deal with the charge; or in some designs a special construction of

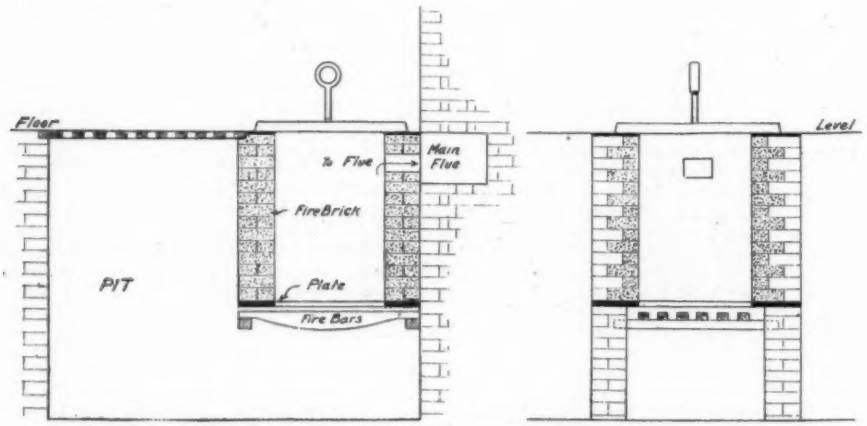


FIG. 2.—CONSTRUCTION OF A SIMPLE COKE-PIT CRUCIBLE FURNACE.

cast- or wrought-iron bars, or the grate may be one circular casting. If the grate bars are made separately they should preferably be made wider at the ends to keep them at their correct distance from each other and allow a free passage for the air. A clear space of an inch or more should be left between the top of the grate bars and the bottom of the furnace, as this assists in allowing a free supply of air.

The size of the furnace inside the lining will depend on the size of crucible to be used, but a space of from 3 to 4 in. all round the latter is generally allowed for fuel. This question has often been a matter for dispute between foundrymen, some claiming that over 4 in. of fuel is desirable, while others have asserted that successful melting can be done with only 2 in. of fuel. But for general purposes it is not desirable to restrict the fuel space to such an extent, unless the furnace efficiency has been proved to be satisfactory with that amount, as poor melting may result. Though it must be admitted that with flue arrangements adapted to regulate the combustion of the fuel, a good deal of economy may be effected by reducing the fuel area. In Fig. 3 is shown a style of furnace in which the grate for the admission of air is built up above the floor level, the furnace top being, of course, raised accordingly.

crucible is employed. Suitable arrangements are made to supply a current of air (usually by a fan) which can be regulated to control the rate of melting, and the fumes from the furnace are conducted through suitable flues to either a stack or outside the foundry.

The great feature of these furnaces is that it is not necessary to draw the crucible in order to pour, and accordingly part or all of the charge may be poured, as required, while the furnace does not materially cool during pouring, but may be immediately re-charged and melting continued. These are important matters as affecting economy both of fuel and time. Since, also, the design of the furnace bears a definite relationship to the charge capacity, fuel wastage is reduced to a minimum, apart from the combustion often being more perfect. The life of the crucible, also, may be doubled and even trebled, as compared with the coke-pit where the crucible has to be drawn, handled, cooled, etc., at each pouring. Hand shanks are used to pour the moulds, the furnace being tilted to fill the shank with the desired amount of metal.

In the writer's opinion the future of brass foundry melting lies with the tilting furnace in some form or other; for the results, from an economical standpoint, which can be obtained from a good design of furnace are really surprising to those accustomed to

only the older form of furnace. Particulary when a foundry is first being equipped this matter is an important consideration. For in view of the claim by some users of good tilting furnaces that these have paid for themselves in one year, the cost of installing them, when off-set by the cost of building pit furnaces, is not so formidable as would at first appear. It should be remembered, too, that a couple of these modern furnaces will deal with the same amount of metal as several coke-pits.

Oil-Fired Furnaces.

While coke furnaces have for a long time held the field for brass melting, during recent years the oil-fired furnaces have come well to the front, and though not yet adopted generally, they have found considerable favour with a number of founders.

From the standpoint of simplicity, the oil-fired furnace is somewhat at a disadvantage compared with the coke fired furnace, as the latter is not dependent on forced draught or any mechanical pressure for supplying fuel, while many designs of the former require a pump to force the oil from the reservoir, and fan or blower to supply an artificial air current to support the combustion of the

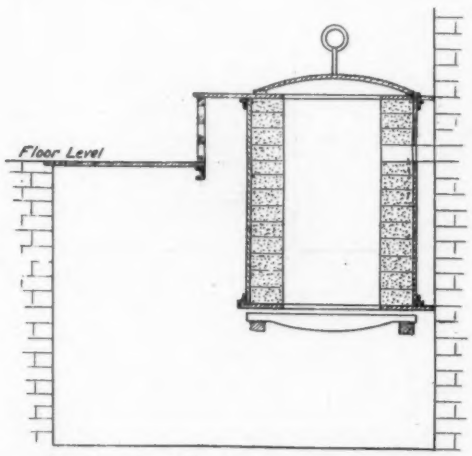


FIG. 3.—COKE-FIRED CRUCIBLE FURNACE.

fuel. The disadvantages thus involved are not of material importance in many cases, and the advocates of oil firing claim that they are off-set by the advantages, but the matter is one for consideration when there is no power for driving pump or blower.

The objection at one time seriously militating against the use of oil-fired furnaces in this country, that a supply of oil is not so certain or convenient as coke supply, does not apply so much at the present day, except perhaps in out-of-the-way places, as oil is daily coming more into vogue as a fuel for numerous purposes; while, also, many of the modern oil furnaces will burn practically any oil creosote, crude oil, petroleum, etc. the burner being constructed to properly atomise the fuel to ensure good combustion.

Among the advantages claimed for the oil-fired furnace is the fact that it is much simpler to operate with a reducing (as opposed to an oxidising) flame, which point is an important one with the non-ferrous metals, in the casting of which the trouble of oxidation is only too present. There is,of course, a great tendency to get a smoky flame—indicative of imperfect combustion of the fuel—in avoiding an oxidising flame, but although this does not make for perfect economy in fuel or the greatest heat efficiency, the effect on the metal is not so detrimental as the effect of an oxidising atmosphere.

Oil-firing, further, is well adapted to the use of tilting furnaces, and these can be built of a much greater capacity than the crucible from the coke-pit, as they do not necessarily have to be handled like a crucible, but can be emptied by tilting the furnace and pouring the metal into ladles for the moulding floor. This has resulted in the development of a number of mechanical furnaces of most convenient design, and some of these are well worth consideration when furnaces are to be installed. The necessity of affording a supply of air under pressure to operate the furnace is well off-set by the fact that the furnace can be kept running the whole of the day, with no great amount of attention. The loss of heat when the crucible is taken out of the coke furnace is not encountered in the oil-fired furnace, as the burner can be kept working and new metal charged into the hot furnace.

Gas-Fired Crucible Furnaces.

Gas firing has probably met with more approval in crucible steel melting than in brass and bronze work, but there is no reason why it should not be more largely adopted for the brass foundry crucible furnace. It is a clean fuel and one that is easily controlled, and provided a suitable furnace is constructed, it has been proved to be an efficient means of melting the non-ferrous metals. The effect on the crucibles is less serious than in the case of coke-firing, as there is no clinker to form on the crucible, and the repairs to the furnace, also, are not so material as the stoking operation necessitated with coke is obviated. The ease with which the temperature can be regulated is also another feature in favour of gas as a fuel.

Electric Furnaces.

As a means of melting the non-ferrous metals for foundry work, the electric furnace has all its application for the future, for up to the present it can scarcely be said to have fairly entered the experimental stage. But the electric furnace has proved such a valuable adjunct to the steel foundry and its efficiency and advantages are so pronounced, that it will probably be only a matter of time before it finds a wide application for first-class brass work. At the moment the cost factor appears to operate against its adoption, but it has been applied to various experimental and research purposes with excellent results—for example, at the National Physical Laboratory for alloys researches.

One of the most important features of electric-furnace melting is the fact that the metal is melted and brought to practically any desired temperature without the introduction of an air current such as is required to support combustion in other classes of furnaces. This absence of air, and consequently oxygen, means that the melting is carried out in a non-oxidising atmosphere, while, also, no furnace gases other than those emanating from the furnace charge are allowed to come in contact with the metal. The process thus approximates more nearly to the ideal than any other method of melting which the foundryman employs.

The author does not propose to touch on the mechanical and electrical problems involved in the construction of electric furnaces suitable for non-ferrous foundry work; suffice to say that what has been done in other fields of electro-metallurgy should prove that such a furnace has great possibilities before it, though perhaps outside the consideration of the small brass founder at the present time.

The advantages of the electric furnace for non-ferrous work are similar to those for other work,

and may be summed up as follows :—The heat can be more readily concentrated in a very small space, and practically any desired temperature can be produced. The melting or refining operations can be carried out in any kind of gas or vapour; or they may be performed in a practical vacuum—more strictly in an attenuated atmosphere—thus avoiding detrimental contact with objectional furnace gases or introduced atmosphere. The desired temperature of the furnace may be rapidly attained and readily controlled and regulated.

The Air Furnace.

While for small and medium-sized work the foregoing furnaces (with the exception of the electric furnace) are used to meet the requirements of the brass founder, where the moulds to be poured are large, involving correspondingly large quantities of metal at one melt, a more capacious style of furnace is necessary. Accordingly, for the larger classes of work such as involve the use of a pit, the air or reverberatory furnace is used. These furnaces vary in capacity from ¾ cwt., upwards, and in general structure are as shown in Fig. 4. The roof is arched so that the flame from the furnace grate strikes the roof and is thrown or deflected on to the charge of metal, which on melting collects in the sole of the furnace, as shown in the illustration, which depicts a reverberatory furnace for handling large quantities of brass or bronze.

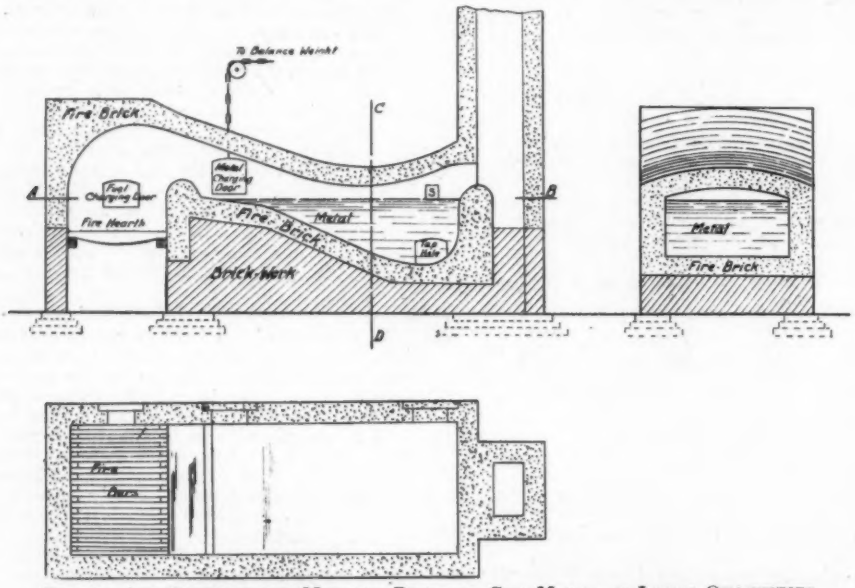


FIG. 4.—AIR FURNACE FOR MELTING BRASS OR GUN-METAL IN LARGE QUANTITIES.

The most suitable fuel for this furnace is a flaming bituminous coal giving a long flame and a dry ash which does not clinker to the bars. The draught used in British practice is generally natural, but forced or induced draught may be employed, though this is not usual for brass melting. The fuel consumption is considered by some to be high in these furnaces, since for brass work a smoky or reducing flame must be obtained. (Were a clear flame employed the loss of zinc through oxidation would be excessive, resulting in bad metal and high expense; it is therefore cheaper to maintain a smoky atmosphere at the expense of extra fuel.) But when compared with the crucible furnace the fuel consumption is not excessive. Under favourable conditions the average consumption of fuel for air furnaces for brass is from ½ to ¾-cwt. of coal per cwt. of the metal, while in crucible practice employing coke the equivalent of this figure would not be considered bad.

The design of an air furnace will be governed by the weight and volume required to be melted in one charge, the quantity of fuel necessary to melt the metal, and the regulation of the air supply for the proper combustion of the fuel used. The first consideration governs the bed or sole of the furnace and the pool for containing the melted metal; the second consideration, in conjunction with the size of the charge and the rate of working required, governs the construction of the grate; and as regards air supply, that must be sufficient to support the combustion of the fuel and must have sufficient velocity on flowing through the fuel to the flue to give the necessary reverberatory effect. The current of air must be sufficiently forceful for the flame to be deflected on to the metal to give the hottest effect. It will be seen, then, that the shape of the furnace must bear a definite relationship to the force of the air current, or the latter will not be deflected in the most desirable manner, and will not thus be properly effective in melting. The nature of the coal used largely governs the arrangement of the grate, and, according to Sharp, assuming that 25 lbs. of coal will be burned per hour for every square foot of grate surface, space must be allowed between the fire bars for the passage of about 230 cubic feet of air for each pound of coal burned in the furnace, or 50 per cent. more than the theoretical volume required.

Owing to the construction of these furnaces, they are subject to the greatest strains when at full heat and with the charge of metal in, and it is therefore necessary to ensure them against failure and collapse by means of casings of iron plates and tie-rods. It is important to select the best of materials for the refractory lining, taking care that the fire-bricks and clay used do not contain matter that will have an injurious effect on the metals being melted. The

joints of the brickwork lining should be as closely and carefully made as possible, to prevent the admission of any cold air, and also to prevent any undue deterioration of the lining during service. Previous to charging, the furnace temperature is raised to a working point and the tap hole closed in the same way as in a cupola. The ingot, scrap, or other metal is then charged through the charging door on to the slope of the basin, the less easily melted pieces being placed on the top in more immediate contact with the heat. The metal when melted runs down and collects in the basin of the furnace, from which it is tapped. Any additions of tin, spelter, lead, etc., that have to be added to the bath are charged into the molten metal through the door S (Fig. 4), and the metal is then stirred by inserting a rod through the opening.

Tapping is done by opening the metal runner by means of a sharp crowbar, and the metal is conducted, generally direct to the moulds, by means of a suitable runner. The tap hole must be proportionately considerably larger than those used for iron and steel, as the metal is less fluid and runs more slowly. This, however, involves no difficulty such as would be experienced in stopping the tap hole of a cupola, as the air furnace melting brass is generally emptied at one tapping. When the slag commences to run from the tapping hole the slag hole is opened and the slag discharged in a suitable manner, generally in a different direction to the metal.

According to the nature of the metal being melted so will the size of the charging door vary. Where big pieces of scrap bronze, for instance, are to be run down, a larger door will be required than for ordinary work, but this is a matter easily decided by the founder when installing his plant.

The regulation of draught is secured by the use of suitable dampers. These may be sliding metal dampers in the stack, but preferably doors fitted to the ash-pit and opening outwards, which can be adjusted as required to regulate the draught. The most economical way in which to operate an air furnace is by continuous working throughout the day, as the heat remaining from one melt is conserved, and the fresh charges are put into a hot furnace. It may be necessary to execute minor repairs to the lining between the heats, but the main repairs can be done after the furnace has cooled down. Ganister or fire-clay is used for the repairs in a similar manner to cupola practice.

When air furnaces are installed it may be taken that the class of work to be handled will include castings of a considerable size, and a casting pit is usually a feature of such a foundry. When this is to be included in the foundry lay-out the general arrangement may be affected thereby; but that is a matter to be decided by the engineer designing the works, who will bear in mind the requirements of each department.

(*To be continued.*)

Melting Aluminium and Magnesium Scrap.

Aluminium and magnesium have already taken a very prominent place in metallurgy. Both of the metals named are above all things deoxidising in their action, and therefore of great use in the production of castings free from blow-holes. Many establishments are compelled to use both these metals in the form of scrap—principally turnings, filings and wire clippings. The following notes from the "Metallarbeiter" should enable this to be done with greater ease and perfection.

It is in the first place necessary to compress the scrap by hammering or other means, as both the metals in question burn very readily when they are in fine strips or in wire form, and apart from the loss which this occasions, the combustion causes slight explosions, By reason of its great specific heat, aluminium melts but slowly. The melted metal shows only a very slight coat of oxide, which, indeed, protects it from further oxidation. In melting the aluminium, one must be very careful not to heat it too high above the melting temperature of about 700 degrees Centigrade; a dark red is sufficient. Slight admixtures of iron, and more especially of copper, are prejudicial for working with the hammer or rolling; silicon is less harmful, but over 2 per cent. makes the metal brittle. Despite that, it may be melted in an ordinary clay crucible without becoming brittle, but, however, no flux must be used (fluxes should always be avoided in melting pure metal) and the temperature must not greatly exceed the melting point. The cohesion of aluminium—that is, that force which binds its own particles together—is greater than its adhesion, or that force which enables it to attach itself firmly to other bodies, as the walls of the crucible; and when the temperature is not too high it appears that there is really no contact between the aluminium and the crucible walls. If, however, a flux is used, adhesion takes place, and the metal takes up silicon from the crucible walls.

Aluminium can be melted also in iron crucibles without becoming damaged thereby, if care is exercised concerning the temperature. At a red glow there is no combustion between the aluminium and the iron; and should such really take place, the alloy will stick to the crucible walls. But in using iron and clay crucibles care should always be taken, especially where the workmen are inexperienced; the slightest inattention on their part can cause the formation of an alloy which for many purposes is absolutely worthless. It is therefore to be recommended that the crucibles be lined with plumbago or with a mixture of some indifferent oxide, as pulverised magnesite and tar. The melting can take place in an ordinary open-hearth furnace, the hearth being covered with charcoal, or in furnaces lined with magnesite and fired with wood or gas. The melted metal is poured into sand moulds. As long as the pouring temperature is not above that corresponding to a dark red glow, there is no danger of silicon being absorbed. If castings are to be remelted, they should be freed very carefully from sand particles on their surface. Scrap containing solder is also to be relieved of this latter material, otherwise the castings will be spotty.

The melting of magnesium calls for other precautious and conditions. This metal melts at a higher temperature—about 800 degrees Centigrade—and the melted mass is less fluid—rather doughy. Slightly above the melting point the metal takes fire and burns to magnesia. For this reason the melting must take place in the absence of air, or in a reducing gas, such as hydrogen or ordinary illuminating gas. The crucibles should be of graphite or iron, with tightly screwed-down covers. In the latter there may be a hole for the admission of hydrogen through a tube, but pure magnesium is obtainable only by distillation. For this purpose, the iron crucible with a perforated cover and a pipe leading from this latter should be used, all the joints being made tight, and connected with an air-tight iron box. The air is driven out from all parts by hydrogen or illuminating gas, and then the crucible heated to a white heat. The magnesium distils over and is collected in a pure state in the box. The heating should take place only after the air has been driven out, as a mixture of air and hydrogen or illuminating gas is explosive.

Setting Pattern Parts in Tops or Copes.

By Joseph Horner.

The setting of pattern parts in tops or copes has to be done when, instead of using complete patterns, the bottom or drag moulds are wholly, or partially swept up in green sand, and the top is either swept up, or else rammed on a bed. The same occurs in many loam tops. When a complete pattern is made, the parts which come in the top give no trouble, being either fastened or dowelled to the main body of the pattern and therefore rammed in place. But when the setting has to be done by measurement the liability to error is great, first, in regard to the setting, then in the risk of the parts shifting during the ramming. In this work the help of the pattern maker is usually requisitioned to set the pieces, and to check them again after they have been rammed. The two general cases which arise may be dealt with separately. In one the top is rammed on a bed; in the other the aid afforded by a sweeping-board is utilised.

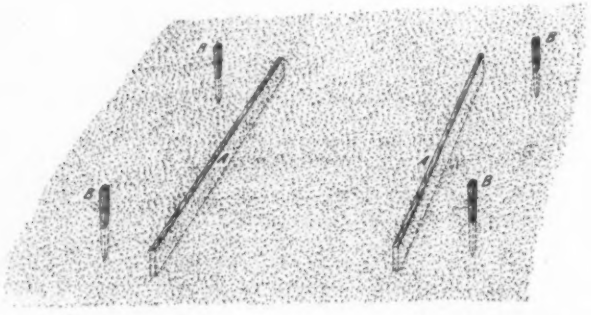


FIG. 1.—BED BEVELLED AND STAKED READY TO RAM TOP ON.

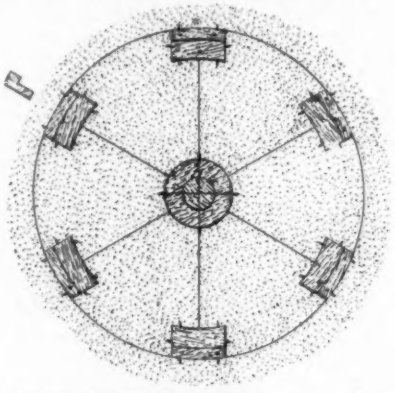


FIG. 2.—PATTERN PARTS SET ON A SAND BED READY TO RAM TOP ON.

In large numbers of green-sand moulds made by sweeping up, with or without the aid of sectional pattern parts, the top is rammed up on the bed which has been prepared for it. Thus, if a green-sand mould is struck up in this way, the cope or top is made before the bottom or drag. The area of the latter is occupied by a hand-rammed mass of sand which is levelled with winding strips, Fig. 1, A, A, bedded in, and strickled off level with their top edges. This would be done if no portion of the bottom mould lends itself to sweeping by a board revolved around a central spindle. On this levelled bed the top has to be set in place by means of stakes B, B, and is rammed on the hard levelled bed of sand. Hence any facings, bosses, lugs, etc., which are required in the top must be laid in their positions on this sand bed, and a nail or two pushed into the sand close beside them will hold them securely while the top is being rammed, Fig. 2.

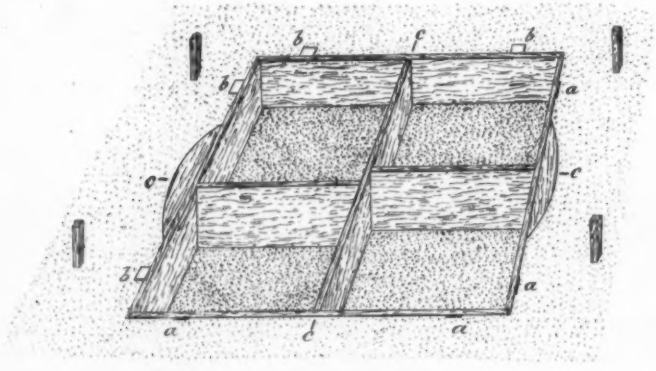


FIG. 3.—MOULDING A SKELETON PATTERN IN THE FLOOR, WITH MARKS AS GUIDES FOR THE TOP.

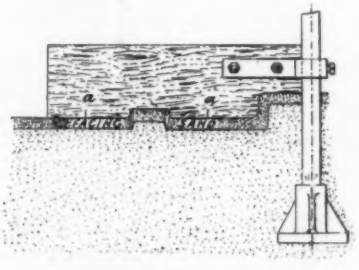


FIG. 4.—SWEEPING A BED TO RAM A TOP ON.

Another case is that of a skeleton pattern—an open frame having no boarded top on which sand can be rammed, Fig. 3. The practice then is to ram a hard and levelled bed of sand, sprinkle it with parting

sand, lay any pattern parts on it, and ram up a plain top or cope on it. Then after the plain open frame in the floor sand has been rammed around its edges, as in Fig. 3, the plain top is set over it by means of stakes, and certain marks are obtained in the top corresponding with the edges of the frame below. This is done sometimes by noting the lines of division between the edges of the pattern and of the mould, as shown by the parting-sand, but this is not very reliable. Preferably, marks are made, such as by sticking up bits of thin hoop iron edgeways at the exact edges of the pattern, Fig. 3, *a*, *a*, which, when the top is lowered down make corresponding impressions therein. Nails are sometimes stuck up in like fashion. Strips of brown paper, moistened with claywash, are also laid along the sand faces, as at *b*, *b*, one edge of each corresponding exactly with the pattern edges; several of these will lift with the top, sufficient to locate the pattern edges, and from these marks measurements are taken by which to set the separate pieces correctly. In some respects the conditions resemble those present when sweeping-boards are used to strike

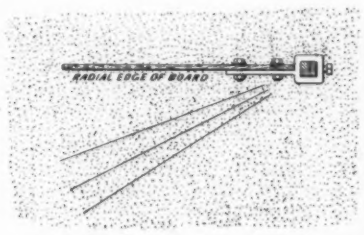


FIG. 5.—USING EDGE OF BOARD TO STRIKE RADIAL LINES.

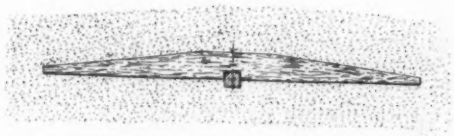


FIG. 6.—STRAIGHT-EDGE FOR MARKING CENTRE LINES ON SAND.

the top directly. In both cases the pieces must be bedded in the top directly, which is a different condition from ramming the top over them when arranged on a level bed, as in Fig. 2. But when a sweeping-board is used, circles can be struck on the sand from its edge, as indicated at *a*, *a*, Fig. 4, using a vent wire, which circles can be sub-divided for the equal setting of facing pieces, bosses, etc. Fig. 4 shows a board sweeping a bed for a top to be rammed on. Radial lines can also be marked by the edges of the boards, as in Fig. 5. In either case the pattern parts have to be bedded-in.

When bedding-in work thus in tops, care is necessary, because, although positions may be marked out all correctly in the first place, there is not only possibility but probability that the pieces will become rammed out laterally, and be considerably displaced ultimately. Hence careful checking is necessary from first to last. Small portions are bedded-in by cutting up the sand, knocking down the pattern portions, and tucking in and around them.

Centre lines and circles are the data from which marking out and setting are done, just as in Fig. 2. Circles are struck with trammels from a centre in a stake driven in the floor, or in the top, as the case may be. Or they are struck with a vent wire from the edges of a sweeping-board, as in Fig. 4. Centre lines are marked from the edges of a straightedge if the centre is unoccupied by a bar centre. If it is, then the edges of the sweeping-board, Fig. 5, can be made the guide for making centre lines by. Or in its absence, a straightedge notched at the centre, Fig. 6, to fit half way round the circumference of the bar can be used. The permanence of centre lines on the sand cannot be retained, yet they are required to check the positions of the pattern parts as the work proceeds. Thin hoop irons, driven into the sand, one at opposite ends of the centre line, and flush with the surface, as in Fig. 3, *c*, *c*, and in Fig. 7, c, c, remain a permanent record of the centre line. Similar hoop irons indicate the pattern edges at *a*, *a*. *b*, *b* show bits of paper. The positions of every piece are marked from centre lines, Fig. 7, just

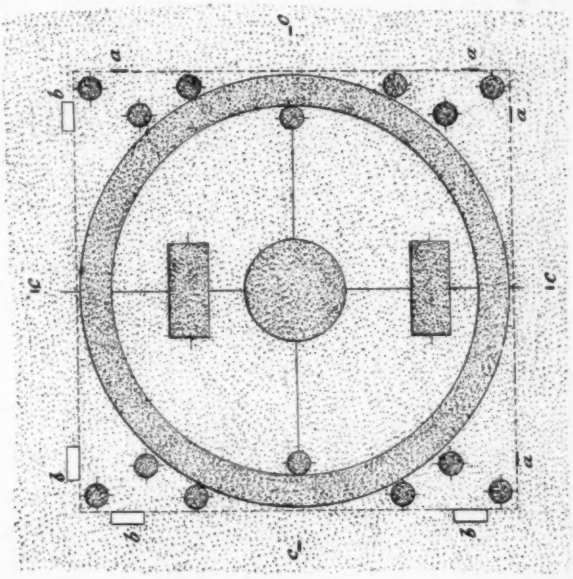


FIG. 7.—POSITIONS OF PIECES MARKED.

as they are given on the working drawings. Sometimes a little very elementary geometry is required, as for raising perpendiculars, sub-dividing circles, laying out angular relations, and so forth, but it does not amount to much.

Besides these relatively minor inaccuracies, big mistakes are liable to occur in lining out and setting pieces in tops in consequence of neglecting to allow for the reverse position which the top mould occupies in relation to the drawings and the bottom mould. When the top mould lies face upwards, or reverse of the view given on the plan view of the drawing, it is evident that the pattern parts must be reversed to right and left, etc. When the mould has numerous separate parts bedded in, it is always safer finally to hold the drawing up to the light, and look through it from the back, and thus compare it with the mould, by which it will be seen at once whether everything has been bedded-in in proper relative positions.

Finally, where numerous parts have been set in a top,

there is always a risk that the joint faces will not coincide exactly with those in the bottom, and, if not, there is imminent risk of crushing of the sand. Hence more care than usual has to be taken after lowering the top into place, to lift it again, and observe if anything has been pushed down, and, if so, to repair it.

A frequent cause of inaccuracy lies in the awkwardness of deep and unsteady portions which, though carefully measured and set in the first place, very often become shifted, and cause the mould to become badly torn. Then the pattern portions have to be put back and bedded in, and the sand made good. Then dimensions must be checked over again.

The same kind of work often has to be done in loam copes which, with rare exceptions, are swept up directly with boards. Then any loose pieces have to be set in by measurement, when all the precautions noted have to be observed; only the plastic loam is more troublesome than the green sand, the pieces being much more liable to become shifted. The work is, therefore, left awhile to stiffen between the roughing and the finishing coats, and the positions of the pattern parts are checked at the last stage.

Points of Dispute between Pattern Shop and Foundry.

By W. P.

One of the many causes of friction between the pattern-maker and the moulder is the question of the amount of draw or taper that is necessary in the pattern. That this should be so is not difficult to understand when the various reasons that determine the same are taken into consideration. The moulder may contend that it is just as easy to put sufficient taper in the pattern when it is being made as it is to make it square, and it is not easy to convince him to the contrary; but, all the same, extra time is required to do so, for it is much easier to work from square faces than from tapered ones. Even with the help of modern machinery, there are many parts and pieces about certain patterns where the taper must be put on by hand.

Complaint is also made that even when the pattern has some taper in it, there is not enough to please the moulder. This may be due to several causes, one of which is that the pattern-maker endeavours to adhere to the dimensions given on the drawing, which seldom shows how the taper should be allowed for; another cause is that in endeavouring to please the moulder the pattern-maker runs foul of the machinist, for, where the parts that are tapered require machining, it is necessary to leave the minimum amount on the small part of the pattern, and this, of course, means so much more to be machined off.

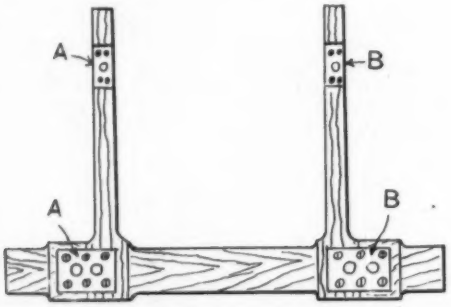


FIG. 1.

At the same time, it must be conceded that in many instances the moulder does not get the consideration he ought, either from the draughtsman, pattern-maker, or machinist. Very often the pattern could be designed with ample taper, without any detriment whatever either to the strength or appearance of the castings, and when this is possible it should be done.

Another matter that is worth attention, is the fixing of rapping and lifting plates, and lifting straps. It is so easy to fix these in the wrong place, and then blame the moulder for not using them; and many a good and costly pattern has been ruined on this account. Of course, that is no reason why the moulder should spoil the pattern, but he ought not to be given the excuse for doing so. As regards the most useful sizes and forms of plates to use, there are a number of these on the market from which choice can be made; generally speaking, it will be found the best practice to use the largest that the pattern will reasonably accommodate.

In addition to those plates which can be bought, there are a large number of special form that will require to be home-made to suit special jobs. These may be made out of such scrap material as pieces of boiler plate, or, if required to be of some peculiar shape it often pays to make a pattern and cast the plates either in malleable iron or steel, or even in brass. It is also advisable, where possible, to use

FIG. 2.

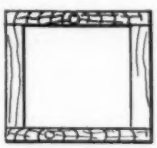


FIG. 3.

bolts for fixing them on standard patterns; this means a plate on both face of the pattern, but it is well worth the extra expense.

Another point to keep in mind when fixing lifting plates is to see that they are placed in position so that the pattern will be balanced when being drawn. In doing this, it may be found necessary to fix other rapping plates in certain parts of the pattern which are not required for lifting purposes. A typical instance of this may be noted in the case of a brake shaft that has the arms cast on as shown in Fig. 1. It will be seen that there are combined rapping and lifting plates at the lower points A, B, and simple rapping plates on the arms at A, B.

Concerning lifting straps, these may be used for patterns of any depth from 6 in., and should always be made to extend the full length of the pattern, with the bottom end turned under; this applies more especially to those box-patterns which are un-

usually deep. Cases have occurred where part of the pattern has been left in the sand through neglect of this precaution, and not only the pattern, but also the mould have had to be made over again. Very damp sand, or, leaving the pattern too long in the sand may have been a contributory cause, but the moulder had an excuse through the straps not being long enough.

Although in some instances it may be found to be the best practice to have the straps let in flush with the face of the pattern, owing to the difficulty of getting at the place, or in the taking up of too much time in making the place good, in many cases, it will not be necessary, as, for instance, where the strap is being put on a core print, or when the inside of the mould has to be drawn away and the recess is easily got at for making up.

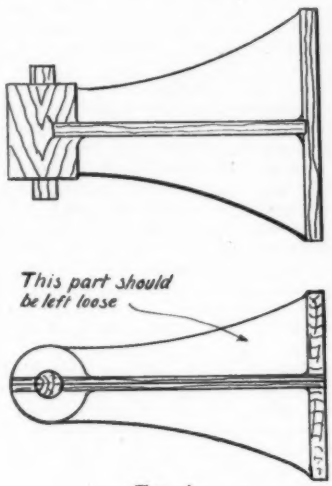


FIG. 4.

Again, referring to lifting plates for standard patterns, it will be found that the life of the pattern will be considerably prolonged if, when possible, the plate is fixed on the bottom, and a hole bored through the pattern to allow for the insertion of the eye-bolt. The destruction of patterns can also be greatly minimised by a little care and attention on the part of the moulder, such as in avoiding, whenever possible, leaving them in the sand longer than is necessary. This is a common source of trouble, for the timber absorbs moisture from the sand, causing the pattern to swell, which makes it all the harder to draw, and often pulls up the sand with it.

Another cause of complaint against the moulder is his continued use of the pattern when the plates have become loose, instead of having them looked to before damage is done. Much can also be done towards the preservation of patterns if the moulder draws the attention of the pattern-maker to where extra plates are required to be fixed in order to help him in the loosening of the pattern.

On further considering the question of making patterns so that they will draw easily and not get stuck in the sand, one of the points worth noting is in the method of boxing up; this is made clear by reference to Figs. 2 and 3. Fig. 2 shows the right way, and Fig. 3 shows the wrong way; as will be seen, the right way is to have the sides carried from top to bottom, for then, should the top board shrink, it would not leave any projection to prevent the pattern from leaving the sand as it ought.

When making patterns that require to have a portion drawn away in the cope, such as the bracket shown in Fig. 4, the top part should be left loose so that it can be taken up with the cope and drawn out afterwards; this will often save a lot of making up, besides producing a better casting. The tendency is to make the pattern all in one, especially when the top portion would be weak if made separate, and the moulder is to blame for this tendency, as there is no question about him not being as careful as he might be in the use of these loose pieces, many of which are, of necessity, only frail structures. The moulder, at any rate, would have more reason to complain, with a chance of his complaint being heard, were he more reasonable in his treatment of the patterns. Of course, he can retaliate by saying that the kind of patterns he is supplied with are not worth any more care than he bestows upon them. That this is often so, cannot be denied; then, the only thing to do is for each to put himself in the other's place, in imagination, and the result will be beneficial to all concerned.

Some Methods of Testing Materials of Construction.

Address before Sheffield Foundrymen.

Sheffield members of the British Foundrymen's Association, on February 21, heard an instructive lecture by Mr. W. Cleland, B.Sc., of Sheffield, on "Some Methods of Testing Materials of Construction." For the convenience of Mr. Cleland the meeting took place at the Testing Works in Blonk Street, and a tour of the works was made with a view of enhancing the value of the lecture to the members.

Mr. Cleland said he had selected the subject not because of any novelty, but because he found there was a great want of knowledge with regard to it. Simply breaking material was not testing it. The act of putting a test peice in the testing machine and pulling it apart was so simple that one was apt to think that no care or thought was necessary to make a satisfactory test.

Considerable care was necessary. If the test was a tensile test then the stress on the test piece should be purely a tensile stress and the centre line of pull must pass through the centre of the test piece, otherwise they would be introducing a bending stress in addition to the tensile. If they were testing an ordinary 2-in. by 1-in. cast-iron test bar under transverse stress, then it was necessary to see that the bending stress took place in the length of the bar and not at right angles to it as well.

A similar reasoning applied to the other tests, shearing, crushing and torsion, to which material was subjected. Mr. Cleland then showed what, in his experience, were the points to attend to and the methods adopted at the Testing Works in order to make careful and satisfactory tests. Material, he explained, was submitted commercially to mechanical and chemical tests to prove its quality, but he, at the moment, was considering mechanical tests only. The kind of stress to which the material was subjected for test was one as near as possible similar to that which the material would be subjected to in use. Thus an impact test was made to show the resistance of the material to shock, but such a test would be useless for cast iron. The mechanical tests applied were tensile, transverse, crushing, shearing and torsion, impact and hardness. These Mr. Cleland described in detail, and at the conclusion of the lecture the members visited the test rooms and saw practical illustrations on the machines.

Briquetting Iron Turnings in the Cupola.*

The modern processes of briquetting iron turnings by heavy pressure (with or without a binding medium) convert the loose structure of the component parts into a solid mass, from which the air has been forced out, so that the whole is sufficiently compact to be used in the cupola without fear of premature disintegration. The waste in the cupola is reduced to a small margin; all kinds of turnings, shavings, etc., can be utilised, either separately or in admixture; and the cupola charges can be graded so as to produce a metal of increased tensile strength and toughness.

Before deciding the question whether the briquetting of turnings is economically advantageous, it is necessary to ascertain if and when such briquettes are disintegrated into their component parts by the heat of the cupola; and whether they disintegrate or melt in the melting zone, like the solid ingredients of the charge, or at a higher level where the absorption of sulphur from the coke begins. In settling this point it must be borne in mind that pig-iron melts very quickly as soon as its powers of chemical combination are destroyed by the attainment of a certain temperature. It is, however, probable that the briquettes, being merely held together by mechanical forces, will fall to pieces some distance above the melting zone.

It must also be borne in mind that briquettes of cast-iron turnings are lower in carbon than the original metal, owing to losses of graphite in working; so that if 30 to 40 per cent. of such briquettes be employed to replace an equal quantity of scrap cast-iron in the charge, the molten product will also be lower in carbon. This is a fundamental condition for the production of compact castings of high tensile strength; but, beyond a certain degree of hardness, the metal will no longer be sufficiently tough to stand fluctuations of temperature. Hence the limits of applicability of such materials will depend on the purpose for which the castings are required, whilst the larger quantities of gas occluded in the molten metal predispose it to piping when cast.

Another important point affecting the use of briquettes is the greater enrichment in sulphur and phosphorus occurring during the melting process. If the briquettes fall apart above the melting zone greater opportunity is afforded for the descending particles to become oxidised, so far as silicon and manganese are concerned, the result being increased waste of material and an augumented content of sulphur, and occasionally of phosphorus. Such a loss of carbon, silicon and manganese is advantageous in some cases, such as metal for cylinder castings, since it enables more expensive materials to be dispensed with in the charge; nevertheless, the higher sulphur content is always objectionable, since not more than 0.1 per cent. of this element should be present in castings that lay any claim to toughness, and when the sulphur exceeds 0.13 per cent. the castings cannot long stand alterations of temperature. This injurious influence, however, may be obviated by raising the silicon content considerably. In fact, with 2 per cent. of silicon, the presence of more than 0.12 per cent. of sulphur will not affect the formation of graphite any more than about 0.08 per cent. of sulphur does in presence of 1.1 per cent. of silicon. The evil effects of a high absorption of sulphur can be counteracted by mixing the cast-iron turnings with those of iron or steel, which absorb sulphur less readily. The absorption of phosphorus is practically negligible, being slight and also counteracting the hardening influence of sulphur.

The two systems of briquetting—the Weiss (in which a binding medium is employed) and the Ronay (without binding medium)—now in use, have been improved in practice by the discovery that the application of very high pressures in the manufacturing process prevents the premature disintegration of the briquettes in the cupola, and also lessens the absorption of sulphur. At present the pressures employed exceed 28,500 lbs. per sq. in.; and the only difference between the two systems is that the Weiss system employs 2 per cent. of lime-water as a binding medium, very little of which, however, remains in the briquettes after the heavy pressing to which they are subjected.

The cylindrical shape of the briquettes—about 5¼ inches in diameter and 4 inches in height, with bevelled edges—is well chosen; and the internal air having been forced out by the pressure, they do not rust in storage. Their high specific gravity (5.0 to 5.8) enables them to remain coherent in the cupola, as though they were of solid material. The waste is small in amount, but of peculiar character produced by the sulphurous gases of the cupola.

Experiments made by plunging a 1-in. iron rod into the cupola showed that the melting zone was about 48 inches in height, and that, above this zone, the sulphur content of the glowing rod had increased from 0.02 per cent. to 0.12 per cent. over a length of nearly 40 inches. From this it follows that the more firmly the briquettes are compressed, the smaller the likelihood of a premature absorption of sulphur above the melting zone. Within that zone itself there was little or no absorption, all the sulphur in the coke having been already volatilised.

Whilst the foregoing considerations do not reveal any superiority of the Weiss process over that of Ronay, it is nevertheless desirable that a certain quantity of solid lime should be introduced into the briquettes, since it is less liable to be forced out than the milk of lime, and it helps to retard the absorption of sulphur. West's experiments have shown that coating pig-iron with limewash reduces the waste in the cupola by 0.63 per cent.

Trials made at the Borsig Works and by the author have confirmed the opinion that the liability of the materials of the charge to become enriched with sulphur varies with their relative specific gravity, solid metal absorbing, for instance, 0.05 per cent., whilst briquettes absorbed 0.075 per cent. The greater loss by oxidation in the case of briquettes is attributable to the lower specific gravity, and consequently larger surface of exposure, a similar result being observed in the case of thin scrap castings. The Borsig experiments also showed that high-pressure briquettes are protected against premature disintegration and oxidation, and render the employment of special iron unnecessary, as also the use of iron and steel scrap.

With regard to the economy of using briquettes, the cost of manufacture by the Ronay process is about 10s. per ton; and if turnings can be obtained without any heavy outlay for carriage, they will only cost about 37s. per ton, as compared with 57s. for scrap cast iron, so that a considerable saving is effected. The greatest advantage, however, is the possibility of dispensing with special pig-iron, owing to the high tensile strength of the resulting metal and the good quality of the castings therefrom. According to figures supplied by Borsig's, the cost of metal for

* A. Messerschmidt, in "Stahl und Eisen."

high-grade castings is between 84s. and 90s. per ton, when special pigs are used, but only 62s. to 65s. per ton when the special irons are replaced by briquettes, so that from 22s. to 29s. per ton are saved. The use of briquettes also increases the tensile strength of the castings by nearly 30 per cent. A rise of even 11s. per ton in the cost of cast-iron turnings would not impair the economical utility of briquettes, in view of the much higher price of special grades of pig-iron.

The practice of using steel and iron scrap to improve the quality of cast iron has now been followed for a number of years; but whilst these adjuncts are preferable for metal that is desired to be mild, but of high tensile strength and tough, they may be advantageously replaced by briquetted cast turnings when hardness and tensile strength are the chief desiderata.

Concerning the process of melting briquette charges in the cupola, the aforesaid alteration sustained by the briquettes in the furnace does not furnish any clear idea of the actual melting process. As the briquettes in the charge descend, the heat of the cupola causes them to crumble at the edges, owing to the internal stresses, and the detached fragments become saturated with sulphur from the coke. In traversing the preparatory zone—a distance of about 5 feet—the briquettes crack, before they begin to melt, and if removed from the cupola at this stage, they will be found of a uniform blue-black colour throughout, from absorbed sulphur, the mean content of which has risen from 0.108 per cent. to 0.118 per cent., the percentage in the external layers being considerably higher than in the centre. When the briquettes have entered the melting zone the molten iron contains about 0.19 per cent. of sulphur, and has, therefore, absorbed about 0.082 per cent., practically no absorption taking place within the last-named zone. This capacity of the briquettes for absorbing sulphur above the melting zone is attributable to their porosity, as solid scrap cast iron absorbs only about 0.05 per cent. of sulphur, so that with scrap alone the percentage of sulphur in the molten metal would be only about 0.158 per cent.

The silicon content does not undergo much change before the melting zone is reached, falling only from, say, 2.25 per cent. to 2.16 per cent., taken at the pasty surface of the metal, so that the loss is no greater than with solid scrap. In the molten metal, however, only 1.10 per cent. will be found out of the above quantity, so that, in passing through the melting zone, the iron has parted with 1.06 per cent. of silicon, and as such a loss is unknown in the case of solid scrap, the question of its cause has to be considered. In the first place, the enrichment in sulphur that has taken place has displaced a portion of the silicon; and in addition the latter undergoes rapid oxidation in the melting zone, in presence of the surrounding free oxygen that is necessary to the proper working of the cupola, the high temperature also contributing to burn off the silicon. During its combustion silicon liberates sufficient heat to melt 29 times its own weight of iron. The reason why there is no increased loss of silicon when the proportion of briquettes in a charge is low (about 25 per cent.) is that the small absorption of sulphur leads to only a slight displacement of the silicon, the combustion of which does not unduly raise the temperature in the zone of combustion.

The high absorption of sulphur by the briquettes results in a considerable loss of carbon (12 to 16 per cent.); and the small amount of silicon left, in consequence of its displacement by the sulphur, has more or less lost its power of facilitating the production of graphite, the iron obtained from briquettes alone being, therefore, white, hard, brittle and useless.

The chief factor governing success in the use of briquettes is to know the composition of the turnings from which they are made, and to employ them in not too large proportion in the charge. Experience teaches that this proportion should not greatly exceed 30 per cent. Both Weiss and Ronay briquettes will give good results, though, in some cases, certain adjuncts are advisable, such, for instance, as an addition of lime, in order to diminish excessive hardness and improve the toughness of the iron; whilst the incorporation of 1 per cent. of manganese ore (with 27 per cent. Mn.) will prevent the absorption of sulphur by the briquettes in the cupola.

Tufnin Flux.

A new purifying agent for all copper alloys is being introduced by Messrs. J. W. Jackman & Co., Limited, Caxton House, Westminster, S.W., under the name of "Tufnin" flux. This flux, it is claimed, volatilises all the impurities in the metal so absolutely, that by its use the elastic limit of brasses and bronzes, such as gunmetal, manganese bronze, etc., is increased by from 15 to 20 per cent. The following test is quoted in support of the makers' claims:—

An ordinary brass with 68.5 per cent. copper and a small percentage of aluminium after treatment with "Tufnin" flux was rolled out into sheets and bars, and showed the following figures:—(*a*) Finished hard; yield point 24.1; ultimate, tons per square inch, 30.4; contraction of area, 63.9 per cent.; elongation in 2 in., 28 per cent. (*b*) Finished soft; yield point 7.1; ultimate, tons per square inch, 23.2; contraction of area, 66.5 per cent.; elongation in 2 in., 67.2 per cent. This metal was made from ordinary best selected copper and Belgian spelter, and it will be seen that its mechanical properties are similar to those of mild steel. For the same brass untreated by this flux the average figures are:—Finished hard, apparent yield point 10 to 12; ultimate, 23 tons per square inch. Finished soft; yield point practically immediate; ultimate, 16 tons per square inch.

Tested at 200 degrees C. a bar of treated metal gave an ultimate breaking strain of 28.9 tons per square inch, and kept stronger than copper up to 260 degrees C. Chilled ingots were bent cold through 300 degrees without a sign of fracture. The resistance against corrosion was as 100 to 56 when compared with ordinary 70/30 brass.

In a 200 lb. crucible 1 lb. of this flux is put on the bottom before charging the metal (in smaller crucibles a proportionately smaller charge). Unlike other fluxes, "Tufnin" flux has the property of remaining on the bottom of the crucible, thus allowing its volatile components to penetrate the whole of the charge of metal as the melting proceeds. As soon as the metal becomes molten, another pound of this flux, to which a handful of powdered charcoal may be added, is put on as a top dressing. The metal is then stirred occasionally with a birch rod or graphite poker, care being taken not to disturb the bottom dressing of the flux. Care must be taken not to overheat the metal, and just before pouring, the bottom dressing of the flux is stirred up and rises to the surface, when the whole of the flux and the impurities it carries are skimmed off. The metal should be poured out at as low a temperature as possible.

The above quantities are for melting new ingots or clean scrap metal. When dirty scrap or turnings and borings are to be melted, double the quantity of flux should be used for each charge. The flux is stated to have no deleterious effect on the crucible. It does not melt, and hence does not form slag in the metal.

British Foundrymen's Association.

Formation of a London Branch.

What might be termed a new era for London foundrymen opened last month, for on the 24th ult. was held the inaugural meeting of the new London Branch of the British Foundrymen's Association—the body which to-day represents the educational and progressive spirit which had been witnessed during the past few years in foundry circles. The meeting was held in the hall of the Institution of Mechanical Engineers, Westminster, and was presided over by Mr. Percy Longmuir, B.Met., President of the British Foundrymen's Association—one of the founders of the parent Association, and well known as a strenuous worker in the cause of foundry progress. Mr. J. E. H. Allbut, General Secretary, to whose efforts the present position of the Association is largely due, was also present, while supporting the Chairman were Messrs. Robert Buchanan and H. Pilkington, both Past Presidents, Mr. J. W. Horne of Messrs. Fraser & Chalmers, Ltd., Erith, Kent, Mr. J. Ellis of Messrs. Flack, Ellis & Company, Southampton, and Mr. J. Oswald of Messrs. J. Oswald & Son, Nine Elms Lane, S.W.

Inaugural Address by the President of the Association.

Approaching fifty gentlemen, representing prominent London and South of England foundries, were present, and to these Mr. Longmuir delivered an inspiring inaugural address, an abstract of which is as follows:—

It is with considerable pleasure that we meet here to-night to inaugurate a new Branch of this Association, and the pleasure is intensified by the fact that the Branch will cover London and district. We hope that the work done will be of such a character as to ultimately lead to the establishment of headquarters here, for the provision of central offices and a library in London would be of very material advantage to the Association. One often hears complaints of the multiplication of technical societies and the prolixity of technical literature. In order to keep abreast of the progress of modern thought reading must necessarily be extensive, and with most people time is short. Not only must current literature be studied, but the work of the past must not be forgotten. Frequently new work will throw fresh light on to old matter, hence the student of any subject must read both past and current records.

To some extent this justifies the multiplicity of Associations and prolixity of literature. To keep up with European and American technical literature is a severe tax on the spare time of any man; for if bulk alone be considered the quantity is excessive, but it would be fallacious to argue from this that further activity should be retarded. Reiterating the words of a past master of research, we may say, publish only that which is original, write it in short, crisp language, and always remember that the reader's time is limited. In other words, avoid waste by concentration. Similar injunctions are applicable to technical societies, for whilst duplication represents waste of effort, the collection of one group of subjects to be dealt with by one Association represents economy of time and energy. The representative tendency of the age is towards specialisation, and what applies to the individual carries equal force when applied to groups of individuals. Instead of overlapping with existing institutions or infringing on any field previously occupied, the British Foundrymen's Association covers a hitherto untrodden field. Its sole concern is the educational side of foundry practice, and its record of work done is most convincing.

The list of Papers read at the various Conventions and at the Branch meetings presents a unique record of the progress of foundry thought. In the reading of Papers many diverse branches of the one subject, foundry practice, have been treated by authors of special experience in the direction selected, and the resulting discussions have evoked experience gained from the hard school of practice and have elicited opinions of high value to the hearers. Although the Association is a specialised body dealing with a special subject, it betrays within the legitimate bounds of that subject a catholic taste and a diversity of opinion. Whilst holding tenaciously to the fruits of experience, it presents a ready ear to that which, though untried, has within itself the promise of practical application. Its members are kept in touch with the best current practice and the latest development in progressive foundry thought. In the proceedings of the Association the science, practice and art of founding each receive attention. The resulting discussions tend to enlarge the boundaries of knowledge and to broaden the outlook of speakers and hearers. Thus the chief aim of the Association is educational; but another aspect is the advantage accruing from the intercourse of individuals having similar objects in life. Informal talk outside the hall of meeting lends to the exchange of experience and thereby assists in the development of a wider outlook. Breadth of view is an asset of considerable importance in every foundry, and in this direction the Association has been most successful. At the Annual Convention, every foundry district in Britain is represented, and the diversity of experience in the members gathered together has a marked beneficial influence. When it is remembered that the membership comprises iron, steel and brass founders engaged in every variety of work, then the value of this personal intercourse will be realised.

As to whether the Association has justified its establishment by the character of the work done, the regular increase in membership, its increased prestige and stability of foundation are ample and complete justification. Possibly the greatest point lies in the character of the "Proceedings," and a cursory glance through these volumes from the commencement is instructive. At the first Convention held in Manchester two Papers were read, while at the last Convention held in Manchester eight Papers were presented, each one of special merit in its own direction. The intervening years between these two meetings have each been marked by progressive steps, and it may be said with perfect justice that each year has been denoted by steady, persistent and forward work. Steady progression of this kind is in the end bound to prove more permanent than spasmodic enthusiasm. Although the growth has been satisfactory, there are still many gaps to fill, and the Association must not rest content until there is an active branch in every foundry centre in Britain. To-night's formation fills one of these gaps, but others remain, and future efforts must be directed to the unoccupied districts of Britain. In the future, as in the past, steady progress alone will mark permanent advance.

We look to the development of the Association into

an organisation of far-reaching influence; issuing a Journal which, in addition to its own "Proceedings," shall give abstracts of the world's foundry literature. We may also look to the time when permanent offices may be established and a library instituted for the use of the members. The British Foundrymen's Association offers every facility for the publication of original work, and as far as present circumstances allow it gives active encouragement for research. We hope that as time progresses, the encouragement will take a more substantial form. It is interesting to note that many of our members have already done good work in this direction.

On other occasions the speaker has indicated the beneficial aspects of research, and this is not the time to reiterate those opinions, but an extra word may be forgiven. Research is simply the accumulation of facts obtained, usually from an ordered and planned investigation. The accumulation of facts is open to all observers with seeing eyes, and as facts are gathered so is research followed. Every new casting constitutes a new problem, and, may be, a certain amount of research has to be done in the way of producing "wasters" before the problem is solved. The present systematic collection of facts means the future success of industry, and to that end will this Association devote its present energies.

Mr. J. E. H. Allbut, at the conclusion of the Chairman's address briefly indicated the financial soundness of the parent Association. On the question of membership, he explained that this gave members the privilege of visiting the meetings of any Branch, where they would always receive a hearty welcome. He mentioned that the Branch recently formed in Glasgow, in which city the next Annual Convention is to be held, has now a membership of over 200. He looked, however, for this progress being exceeded by that of the London Branch.

Mr. H. Pilkington reminded the audience that the Institution of Mechanical Engineers, in whose magnificent building they were assembled, began in Birmingham in a very small way. He drew attention to the annual volume of "Proceedings" of the British Foundrymen's Association which was about to be issued to the members, and remarked that it was an exceedingly valuable volume. Foundrymen, he said, had a lot to learn, and the Association was a valuable opening for obtaining practical and scientific knowledge. On the question of the London Branch, he remarked that the Central Council did not interfere with the affairs of the Branches, but helped them with Papers, lecturers and in other ways, while allowing them the freedom of self-government.

Mr. Robert Buchanan spoke highly of the educational value of the Association, and claimed that none had learned more from it than he himself. But the hearing of the Papers read was the lesser part of that education; the close acquaintance with fellow workers in the trade was still more beneficial. The Association brought them into touch with the best practice in Great Britain, which meant the best practice in the world. It was time that the status of the foundry was raised; it had too long been the step-child of the engineering industry, but engineers were at last beginning to realise its importance. Members might be assured of every assistance, and he hoped that they would in turn assist in keeping this country in the forefront of engineering practice.

Mr. Oswald then moved the inauguration of the London Branch.

Mr. Horne seconded, and the proposal was carried unanimously, after which Mr. Horne proposed the election of Mr. J. Oswald as first President. Mr. Oswald, he said, was well known in the industry, was a member of the Junior Institution of Engineers, and a member of the Institution of Mechanical Engineers.

Mr. Ellis seconded the proposal, which was supported by Mr. Longmuir, and carried unanimously.

Mr. Oswald, having thanked the meeting for the honour of electing him first President of the London Branch, then proposed Mr. T. Murphy as Secretary, which proposal was carried.

A Committee of seven, with powers to raise their numbers to 12, was then elected, consisting of Messrs. J. W. Horne, A. Whiting, J. Ellis, E. A. Chell G. B. Henderson, S. Waterhouse, and R. Woods.

Votes of thanks to the Institution of Mechanical Engineers for the use of their building, and to Mr. Percy Longmuir and the Council for their attendance and help, were then heartily accorded, after which the meeting terminated.

Recent Progress in the Electro-metallurgy of Iron and Steel.

A two-ton Röchling-Rodenhauser electric combination induction furnace is to be erected by the American Electric Furnace Company of New York some time during this year at Lansdowne, Pa. This is the first furnace of this type to be installed in the States.

The Girod furnace installed by the Simonds Manufacturing Company at Chicago is now being transferred to their new and modern plant at Lockport, N.Y., and will be used for producing and refining the high-grade steels required for their saws, machine knives, files, etc. A new 20-ton to 22-ton Héroult furnace—the largest in size so far—is soon to be erected in a German works. In another German works using the Hérouit furnace (seven tons capacity) the energy consumption (with fluid charge) is given as 105 kw-hours per ton of steel.

From Messrs. C. W. Leavitt and Company of New York, the American representatives of the Girod furnace, we have received the following data on the experience of the Cockerill Company in Seraing, Belgium, who have been operating a 4-ton to 5-ton Girod furnace for the past two years and are refining molten basic steel for rails, locomotive tyres, cannon, automobiles, etc. The total cost of power, labour, furnace upkeep, electrodes, and general expenses for the operation of this electric furnace is given as less than 16s. The Krupp firm in Essen is installing a 12½-ton Girod furnace to be operated by three-phase current.

As to the reduction of iron ore in the electric furnace interesting information comes from Scandinavia. The large 2,500-h.p. electric shaft furnace at Trollhättan was put in operation in November and appears to work perfectly well. The furnace was first tapped on November 16th, and from a private report written two weeks later we learn that the furnace had been working without difficulty since the start, and especially that none of the electrodes had been touched in that time. From another report, dated December 10, it is learned that the furnace had been running continuously since November 15 and was working quite satisfactorily. The furnace plant is equipped with apparatus for making gas analyses and taking temperatures at every 3 ft. of the whole stock. There is also a very elaborate laboratory for testing the raw materials and the product obtained. The yield was for the first week 2,900 kg. (6,578 lbs.) per h.p-year, but has since been raised to above three metric tons (about 6,600 lbs.) per h.p.-year. The consumption of coal amounted to 24-26 hectolitres (85 cub. ft. to 92 cub. ft.) per 1,000 kg. (2,204 lbs.) of iron.

At Domnarfvets, where the first electric iron-ore smelting experiments by this system took place, a new furnace for from 4,000 h.p. to 5,000 h.p. is at present under erection. It is expected to be ready for operation in May.

Volume Changes in Cast Metals.*

By Professor T. Turner, M.Sc.

Perhaps one of the most important metallurgical discoveries of recent years has been that materials which were formerly considered to be uniform throughout and perfectly homogeneous are really very complex aggregations. It had long been recognised that cast-iron is not a homogeneous material, and that wrought-iron consisted of fibrous or lenticular portions interstratified with a certain proportion of cinder. But when the Bessemer process introduced mild steel this was not unfrequently referred to as "homogeneous" metal, and was supposed to be absolutely uniform in every part. This view was first shown to be erroneous when Snelus took drillings from various portions of an ingot, and proved that segregation took place, as a result of which the upper central portions of the ingot, which solidify last, are richer in impurities, and particularly in carbon and phosphorus, than the portions which first solidified. It was still supposed that the greater part of the ingot was made up of uniform material until Sorby, by microscopical observations, recognised that in mild steel there were two quite distinct constituents, was of which was commercially pure iron, or, as it is now called, ferrite, while the other, which is richer in carbon, has a peculiar appearance and structure to which the name pearlite is applied. Further investigations have shown that the carbide of this pearlite can be made so fine in texture as to be invisible to the microscopist, or so coarse as to ultimately deposit carbon. The application of the microscope to other commercial metals and alloys has demonstrated that these substances are almost invariably of complex constitution, and that their properties depend quite as much upon their proximate as upon their ultimate composition.

The extraordinary change which occurs in carbon steel during heating and cooling, which was first described by Gore, and which is known as recalescence, was the starting point of researches, conducted by many observers, usually with the aid of the Le Chatelier pyrometer. The result of such work has been to show that few metals or alloys absorb heat quite uniformly when being heated, or evolve heat quite uniformly when cooling. These irregularities or arrests are connected with internal re-arrangements, or molecular changes, which are often of profound importance. Among the earliest results from this line of enquiry was Osmond's recognition of the three allotropic forms of iron, which are called respectively *alpha*, *beta* and *gamma*; while from the more recent mention may be made of Benedick's work on the three allotropic forms of zinc. Similar methods of enquiry are now being largely applied by the chemist and physicist to non-metallic substances, and it has been proved that solid water, or ice, exists in three forms. One of these is the ordinary, or stable, variety, which has expanded before and during solidification; the second is metastable, and its formation depends upon expansion being prevented: while the third kind can only exist within certain ranges of low temperature.

The remarkable expansion which normally occurs during the formation of ice naturally leads to the consideration of abnormal volume changes in metals and alloys. Speaking broadly, solid metals expand more than non-metallic solids for equal increments of temperature, and, on cooling, exactly recover their original volume. It has, however, been long known that when a piece of ordinary carbon steel is very rapidly cooled from bright redness it becomes larger and less dense than it was before being so treated. Conversely, a steel wire, when heated through a temperature of about 700 deg. C, becomes appreciably shorter at that point. Cast iron also is increased in density and decreases in bulk as a result of chilling; but malleable cast iron, on the other hand, has its volume increased, and its specific gravity diminished during the process of annealing.

Numerous investigations have been conducted by physicists, in which the expansion of metals has been determined with great accuracy over a certain limited range of temperature, say from 0 deg. to 100 deg. C. Mallet, Roberts-Austen, and Wrightson also studied the behaviour of molten metals at and above their melting points. But the intermediate range of temperature was generally neglected, and nothing really quantitative was known concerning volume changes which occur in hot solid metal until Keep's researches, in connection with cast iron, were published in 1895.

The method adopted by Mr. Keep has been frequently described and is now tolerably well-known. It consisted of casting a bar in a sand mould in which two steel pins were placed, one at either end of the mould. To these pins levers were connected, so that the changes in length of the bar could be recorded from the moment it became solid until it had completely cooled down. This method was shortly afterwards modified in my laboratory so as to allow the temperature changes to be recorded side by side with volume alterations. For this purpose a T-shaped test bar was employed.

In another form of the apparatus, used when smaller changes in length have to be examined, a reflecting mirror-form of extensometer is used, in order to increase the magnification and to diminish the weight. Dr. Wüst has also done useful work with a form of apparatus in which the motion of a cast bar is communicated to a column of water in a narrow glass tube.

The result of the application of these methods of investigation has been to prove that while some metals contract quite uniformly from their melting point to the ordinary temperature, other metals and alloys show distinct arrests in the rate of contraction during cooling, and in some cases show very marked expansions. These arrests in the rate of cooling are invariably connected with temperature changes of a corresponding nature. It has, for example, been shown that with white iron there is only one relatively small expansion, which occurs at about 700 deg. C.; while the grey cast iron which contains no phosphorus there are two expansions, one being in the neighbourhood of 1,050 deg. C. and the other at about 730 deg. C.; with grey cast iron which contains phosphorus there are three well-marked expansions occurring at about 1,050 deg., 900 deg., 730 deg. C. respectively, and corresponding with the separation of primary graphite, the phosphorus eutectic and secondary graphite respectively. The more recent work in connection with cast iron embraces researches in the influence of silicon on cast iron by Mr. Hague and the author, and on the effect of manganese on white and on grey iron respectively. The latter research was carried out by Mr. Coe, and both papers were read at the last meeting of

* Abstract of Paper read before the Staffordshire Iron and Steel Institute, at Dudley, February 18.

the Iron and Steel Institute. They will repay study by those interested in the subject.*

Important results have also been obtained in connection with alloys, Mr. Murray having shown that in the copper-zinc series alloys which contain 60 per cent. and also those containing 40 per cent. of copper do not expand on solidifying, but that cast bars of those with 85 per cent., with 50 per cent., and with 15 per cent. of copper show expansions which are sometimes of a very marked character.

In the discussion of certain of these papers a question has been raised as to the interpretation of the results, and suggestions have been made that the expansions recorded may be more apparent than real. In other words, that though the casting itself has expanded, the actual metal of which the casting is made has not altered in volume. From a practical point of view the question is perhaps of little importance, as the changes recorded by the extensometer are such as will actually occur in practice, when castings are made in the foundry; but, theoretically, the question is of interest, and may perhaps with advantage be more fully discussed.

The criticism of the method adopted was expressed by my friend, Dr. Desch, who stated that he quite agreed that the volume of a cast bar would vary in proportion to the length after the bar was once really solidified, but that during the process of solidification they were not dealing with a constant quantity of metal.

No doubt when a bar of metal is cast the outer portion solidifies first and the inside remains longest liquid. It is possible, though as yet unproved, that in certain cases of low melting point alloys, where only a small expansion is observed immediately at the beginning of the extensometer record, crystal thrust may act as suggested by Dr. Desch; but that in bars of metals such as the founder generally employs, the increase of length corresponds with actual expansion of metal, I shall now proceed to prove.

In the first place, it will be evident that if the outer solid shell of the bar expands owing to crystal thrust, then either more metal must flow in from the gate to fill up the cavity, or holes must be produced in the casting. Now neither of these things happen, since the metal in the gate is usually quite solid before the expansion commences, and the bar shows no cavities when microscopically examined. Any inflow or outflow of liquid metal has therefore ceased when the expansions begin, and subsequently the whole bar expands or contracts together. The conclusive proof on this particular point was supplied by Mr. Keep in his original experiments on cast iron.

The object of Mr. Keep's experiments was to determine the connection between the expansions and the separation of graphite. For this purpose arrangements were made by which 18 bars, each one inch in square section and one foot long, were cast out of the same ladle, and at the same instant. An automatic recorder showed the expansions of one bar, while the others were examined in order. Each bar was in turn rapidly stripped from the sand mould and broken into two pieces, one of which was immediately chilled in ice-cold water. The object of the chilling was to retain the carbon in the form in which it existed in the bar at the particular temperature. It was thus possible to follow the gradual separation of graphite and to connect it with the recorded expansions. These results in reference to graphite were of the greatest possible importance, but for our present purpose the interesting observation is that though at the end of *one minute* the metal was still fluid in the gate of the first bar, by *one-and-a-half minutes the bar was solid.* The sand was then got away, the bar was drawn out, and one-half of it was thrown into ice water and chilled. This bar, though solid, was sufficiently fragile to break by its own weight when being taken out of the mould. At the end of each minute another bar was taken from its mould, broken, and one-half quenched in ice water as before. Each successive bar increased in strength, and the last bar required a considerable blow from the hammer to break it. The important point is that on examining the curve it was found that the test bar began to expand at one-and-half minutes after pouring, showing, as Mr. Keep observes, "that it did not expand during solidification, but that all the expansion occurred in the bar after solidification."

When the last bar was removed from the mould it was still visibly red hot, and the experiment was not continued further, as it had already been shown that below this temperature cast iron contracted uniformly. The three expansions which take place in ordinary cast iron, therefore, occur between the point at which the just-solid cast bar can be lifted out of the mould without any loss of metal, on the one hand, and a low red heat on the other. In the case under consideration, with one inch bars, while complete solidification only occupies one minute, the expansions extend over a period of fully 18 minutes. In such a case crystal thrust is evidently out of the question.

The pyrometric evidence which has since been obtained entirely supports the correctness of the observations of Mr. Keep. When a bar of iron is cast into a sand mould four temperature arrests are very commonly observed. The first of these corresponds with the beginning of solidification, or, in other words, that of the crystallisation of the solid solution of carbon in iron which is called Austenite. With rapid cooling this point is not very well defined, and may sometimes be missed altogether. The next arrest is the one which is frequently the first recorded; it occurs at a little over 1,100 deg. C., and indicates the solidification of the iron-carbon eutectic. In other words, at that temperature the whole mass has become solid. An examination of the temperature arrests side by side with the expansions will at once indicate that the first expansion becomes pronounced at about 1,060 deg. C. or about 70 deg. below the solidification of the iron-carbon eutectic. It is to be noted that the maximum of the first expansion, and the whole of the second, and of the third expansion occurs below this temperature of 1,060 deg. In such a case it is impossible to conceive of ordinary crystal thrust playing any part.

Lastly, it may be pointed out that the density of cast iron which has been allowed to cool slowly, and hence to expand in the normal manner, is less than that of the same metal when expansion has been prevented by rapid chilling. The increase in volume is thus not merely an apparent one, but is very real, as every engineer shows, when he allows a different weight per cubic foot for grey iron than for white iron. While a cubic foot of pure white cast iron weighs about 475 lbs., a cubic foot of dark grey cast iron only weighs about 425 lbs. The extreme difference is, therefore, as 100 is to 89.5. Part of this difference is caused by silicon. It will be approximately true to say that if 20 volumes of white chilled cast iron are re-melted and very slowly cooled, the volume of the resulting grey cast iron will be 21, and the increase in volume is due to the three expansions previously mentioned.

From the foregoing considerations it may be claimed, without fear of contradiction, that crystal thrust is not the cause of the changes of length observed in a bar of cast iron during and after solidification. These changes occur in the solid bar and correspond with the separation of definite and well-recognised substances;

* See FOUNDRY TRADE JOURNAL, January and February, 1911

they are associated with an actual increase in bulk, and a reduction in density of the bar.

A little reflection will show that the study of the volume changes in castings is of great importance to the practical man, and of much interest to the scientific investigator. Probably the first observation in the iron foundry is that metal which shows marked expansions on the extensometer is a soft fluid iron, which fills the mould well, while it takes sharp impressions, and has clean, smooth surfaces. Of metal which shows little or no expansions the converse is true.

But beyond this simple statement there is much to learn and to apply. In the case of a casting with thick and thin parts the thinner portions may readily cool below 700 deg. C., and therefore be rapidly contracting, while the thicker parts may be above 900 deg. and so be expanding. Further, the rapid cooling, or chilling, of the thinner parts will prevent the normal amount of expansion taking place, and hence thin bars always contract more than thick ones. It is this behaviour which renders it so important to make castings as uniform in thickness as possible in order to avoid fracture during cooling, or perhaps even subsequently, owing to the internal strains which are produced. The advantages obtained by opening that portion of the mould near where the thick part of a casting lies is also explained by a knowledge of the expansions which take place, and the order in which they occur.

Queries and Replies.

Trouble with Gunmetal Test Bars.

I have experienced trouble in getting satisfactory tensile test results with Admiralty mixture of gunmetal, *i.e.*, 80 copper, 10 tin, and 2 zinc. I can get correct analysis, but never more than 10-ton tensile strength with an elongation of 6 per cent. on a test bar 2 in. on stretching length, and 0.798 in. diameter. The metal is melted in a tilting furnace of the Baumann type and poured by means of ordinary ladles. I shall be glad of any practical advice which will help me toward getting a 14-ton tensile strength with an elongation of 7½ per cent., as called for by Admiralty requirements. "H. H. M."

Glutrin as a Sand Binder.

Can you give us any information as to the use of glutrin in moulds for steel castings? "A. B."

Answer.—In the steel foundry glutrin has practically superseded molasses and other materials formerly used for sand building, on account of the many advantages it possesses. As compared with molasses, only about half the quantity of glutrin is required, the binding effects of glutrin being considerably greater; and it is found that when the castings are removed from the moulds, the sand comes away much more freely from the casting than is the case when molasses is used. Another advantage is that less clay requires to be used in conjunction with the glutrin, and it is found that when the moulds in which glutrin has beed used are dried that the glutrin has the property of fixing the paint on the moulds, thereby ensuring cleaner castings.

THE partnership heretofore subsisting between Messrs. W. Robinson and J. King, carrying on business as engineers and makers of axle pedestals, at 8, Bond Place, Leeds, under the style of W. Robinson & Company, has been dissolved. Mr. Robinson will in future carry on the business under the same style.

Electric Steel Refining.

The following notes are abstracted from a Paper read by Mr. D. F. Campbell before the last Autumn meeting of the Iron and Steel Institute.

The use of electricity for the refining of steel has now taken its place amongst established metallurgical processes, and many papers have been written on the subject of electric furnaces, but the author proposes to discuss briefly the general aspects of the subject, and what he considers the probable and possible developments in the immediate future in England. The electric furnace is at present used in various works for the refining of steel from the Bessemer converter in the manufacture of rails and all classes of railway material and castings, and more commonly in connection with the basic open-hearth process for the manufacture of various products of intermediate quality, castings and tool steel of all kinds. These are the purposes for which it has been most widely adopted, notably in America, Germany, and France, though it is also used for melting and refining charges of cold scrap of cheap quality for the manufacture of tool steel and small castings, and its high efficiency is now generally acknowledged. The refining of steel that had been previously melted was the first use to which the electric furnace was applied commercially; but now that single furnaces have been producing over 200 tons a day for more than 16 months, it is obvious that the field for the process has widened, and already many furnaces are in construction or operation in this country.

In the case of a basic open-hearth plant, using 60 per cent. of molten pig-iron and 40 per cent. of scrap, a 40-ton furnace might have 15 tons removed to the electric furnace for refining, and a similar charge put in every two hours. Thus the capacity would be increased, the quality improved, and, in addition, a reduction in the cost of raw materials can also be made in some cases, as a low quality of pig-iron can be used.

Similar conditions occur when working in conjunction with an open-hearth plant for making castings, and a thoroughly dead melt and extreme fluidity can be obtained, while the commonest raw materials can be used, and refined completely. This gives economy both in the amount of gits and runners, and also in the reduction of wasters. Even in the case of foundries engaged in ordinary open-hearth casting work, in which the margin of profit is now exceedingly small, the electric furnace is considered necessary for an improvement in quality, while in a small foundry making light and intricate castings from crucible steel, an economy of several pounds per ton may be expected to result from the adoption of the electric furnace, judging from the reduction of the costs in works in Germany where crucible furnaces were replaced by this process.

There is little doubt that crucible steel, Swedish billets, and products of intermediate quality, such as are used for the Sheffield trade and by tube-makers of Staffordshire and South Wales, can be economically replaced by steel refined by electricity, and made in Middlesbrough, Cumberland, or the larger steelworks in the Sheffield and Rotherham districts.

In the electric furnace almost any degree of refining can be economically effected, and the removal of sulphur, phosphorus, and oyygen is especially easy. This is probably due to at least three causes:—(1) The intense heating of the slag, which is the place at which refining takes place. Owing to this high temperature and the extreme fluidity of the slag, the rate of refining reaction is very

great, because the velocity of reaction rises very quickly for high temperatures, and not in direct proportion to the temperature. (2) The extremely basic slag that can be kept in a very fluid state, and the calcium carbide formed by the action of the arc on the calcareous slag, are especially advantageous for desulphurisation. (3) The violent motion of the steel, which results from the convection currents produced in the bath, due to the two intensely hot areas caused by the arcs below the electrodes, increases the volume of steel exposed to the hot and fluid slag area, and hence the rate of refining.

The usual procedure for the use of the electric furnace in connection with the Bessemer converter is to charge the steel, holding back all slag in the ladle, after putting on the bottom of the furnace lime and mill scale or iron ore. This produces an oxidising or dephosphorising slag, which may be carefully skimmed or poured off. On the bath of steel carbon is thrown to carburise to any required degree, and then a second highly basic and desulphurising slag is added. The arc acting on the calcareous slag produces calcium carbide, which may combine with sulphur to form calcium sulphide. As neither gases nor air enter the furnace, and the conditions are almost completely reducing, no sulphates are formed, a dead melt is easily obtained, and when the slag is molten and the requisite heat obtained, the steel is teemed. In the open-hearth or any oxidising furnace these reactions cannot take place so completely and efficiently.

With steel from the basic open-hearth furnace, the procedure is similar, but when the quantity of phosphorus to be removed is small, it is only necessary to use one refining slag for the elimination of sulphur and any small amount of phosphorus remaining. The usual pratice is to put the carbon necessary for carburising in the bottom of the furnace and then add the steel, and the basic slag materials. As soon as the teeming heat is obtained, the necessary ferro-alloys are added and the steel will be completely refined.

Another point of interest is the rarity of blow-holes in electric steel when properly made, and this leads to the question of the cause of these troubles. It is well-known that any ingot of steel when placed in a vacuum evolves nitrogen, and this is about equally true whether it be made in the crucible, the Bessemer converter, or the electric furnace. Blow-holes contain nitrogen, but this is probably not the cause. It is far more probable that they are due to the combination of oxides with the carbon in the process of cooling, and that the carbon monoxide so formed at a high temperature causes blow-holes in the cooling steel, and owing to the diminution of volume of the carbon monoxide on cooling, a partial vacuum is formed, and nitrogen is sucked into the blow-holes. In electric steel, oxides do not occur in any quantity, and consequently the prime cause of blow-holes is reduced.

Again, the quality of electrically refined steel is better than a material of similar chemical composition made in any oxidising furnace. This is probably due to the reducing conditions under which it is finished.

It must not be forgotten in discussing these special qualities of electrically refined steel, that some inferior material has been made by incompetent melters or ineffective furnaces, and that the electric, just as much as any other furnace, required trained men, and most careful designing by metallurgists who have made a special study and had practical experience in this subject.

The question of the cost of applying this process, which must be considered before all others, is more difficult to discuss generally, owing to the great variety of conditions. The following are the chief points, all of which must be carefully considered in each particular case :—

(1) The possibility of saving in cost of raw materials, since the best qualities of steel can be made from impure raw materials. For example, in the case of refining steel from open-hearth furnaces in the South Staffordshire district, the use of local pig-iron as compared with hematite iron would effect a saving of several shillings per ton owing to the high railway rates.

(2) Possibility of increasing the output of present furnaces by the addition of electric furnaces with improvement of product. For example, in the case of Talbot and other open-hearth furnaces, where a large expense is incurred in the removal of sulphur and getting a teeming heat, the steel can be advantageously transferred to an electric furnace for desulphurisation and the output materially increased. The Talbot or other tilting furnace is especially satisfactory owing to the facility with which charges can be transferred to the electric furnace, whenever required.

(3) The cost of power and possibility of using blast-furnace or coke-oven gas, exhaust steam, etc., will be the determining factor in regard to deciding whether, in the manufacture of steel, electric refining can be economically adopted. In the case of cheap power or valuable products, scrap may be economically melted and refined in the electric furnace at a current consumption of 700 to 800 kilowatt-hours per ton, or if the price of power be high, the steel may be merely desulphurised and deoxidised, after melting and dephosphorising in a basic furnace, with a power consumption of 100 to 150 kilowatt-hours per ton.

(4) The possible reduction of capital expenditure at certain works where the present products are not sufficiently good for modern specifications. This may involve the entire re-organisation of the works, but it is often cheaper and more efficient to add an electric furnace to a Bessemer plant, than to replace the latter by open-hearth furnaces.

The author does not wish to compare the different types of electric furnace in this Paper, but the figures given are taken chiefly from Héroult furnaces in America, England, Germany, and France, as this type has been far more widely adopted, and is used in larger units than any other, and single furnaces are now refining 250 tons per day.

The adoption of electric refining will cause some readjustment in the steel trade. As soon as the Sheffield steel-melter has become acquainted with the process, and accustomed to the working of electric furnaces, electrically refined steel will largely replace ordinary crucible steel. This has already occurred in Germany and America, where electric furnaces are used to make all classes of special and high-speed steels, the usual practice being to refine metal from a basic open-hearth furnace. Large crucible plants and small open-hearth furnaces engaged in the manufacture of small and intricate castings, such as motor-car parts, etc., may be replaced by electric furnaces, because the high degree of fluidity and dead melt obtained is especially advantageous.

In many cases manufacturers of axles, guns, and tubes will abandon the use of Swedish raw materials, and refine steel made from low-grade ores, thus reducing the value of high-grade ore deposits and the quantity imported; for, by the use of electricity, Cleveland stone will produce a steel equal to the best hematite ores. The capacity of many Talbot and basic open-hearth plants will be increased and the quality of the product improved, while much of the power that is now going to waste will be utilised for steel refining.

The "F.T.J." Bookshelf.

Practical Alloying.

By J. F. Buchanan. Cleveland, Ohio, U.S.A: The Penton Publishing Co.

Scanty enough is the literature of a practical nature on the production and handling of the commercial non-ferrous alloys; but here, at least, we have a plain, practical work that should not be beyond any foundryman's comprehension. The author throughout writes as with a full knowledge of both his subject and audience, and consequently the stamp of practical utility is placed on each page, making it a handy guide to the practices and processes of alloying. An interesting general chapter opens the book, and discusses briefly the work of the alchemists, chemistry and metallurgy, the treatment of various kinds of ores and the different processes of reduction. The author then comes to the history and peculiarities of alloys, the properties of alloys, and some difficulties of alloying. The next chapters deal with methods of making alloys and the colour of alloys, while in a further one on the notation of alloys is presented a table showing the systematic notation containing symbolic equivalents for many commercial mixtures. A comprehensive section of the work then treats with standard alloys and foundry mixtures, giving the compositions of many well-known mixtures and instructions on the making of various alloys, while white metals, solders, novelty metals, etc., are further subjects, followed by a useful chapter on fluxes for various mixtures. Nor is the moulder forgotten, for a useful chapter deals with gates and risers, showing proper and improper methods, and giving a lot of valuable information. Some notes on crucibles follow, after which a chapter deals with the testing of alloys. The book concludes with some extremely useful tables relating to metals and alloys, and a handy index.

Lectures on Iron-Founding.

By Thomas Turner, M.Sc., A.R.S.M., F.I.C. Second Edition. London: Charles Griffin & Company, Limited, Exeter Street, Strand.

Professor Turner's lectures have met with such general approval, both on the platform and in book form, that there can be no doubt about the second edition of this little book being well received. The matter in the previous edition has been revised, and references have been introduced to recent work on the physico-chemical side of the subject, and to volume and other changes which take place during and after the solidification of cast iron, but the general scope and arrangement of the book is otherwise unchanged. It is probably too well known in its former edition to require more than brief mention at the moment; and, in any case, Professor Turner's reputation as an authority on the subject of cast iron is a sufficient guarantee of its value to justify its claims to importance as an aid to the iron-founder.

Mechanical Engineering for Beginners.

By R. S. M'Laren. Second Edition. London: Charles Griffin & Co., Ltd., Exeter Street, Strand, W.C.

In view of the fact that the first edition of this book was published as recently as 1908, the issue of a second edition is a testimony to the approval with which it has been received. It is certainly a very suitable work for beginners, for not only does it give the broad outlines of the subjects treated, but it goes into sufficient detail to enable the student to make all the calculations likely to be required during the earlier stages of his work. No attempt is made to describe those mechanical processes, a knowledge of which the student acquires in the workshops; the object has been rather to condense the matter which can usually only be obtained in a number of more exhaustive works, and place it before the beginner in a handy and concise form. Following the opening chapters on materials, bolts and nuts, studs and set-screws, and boilers of various descriptions are dealt with. Steam-raising accessories, and steam-pipes and valves are next treated, followed by two chapters on the steam engine. Power transmission is the next subject, and the following two chapters deal respectively with condensing plant and the steam turbine. An electrical chapter is followed by one on hydraulic machinery, after which gas and oil engines come up for consideration. The concluding chapter deals with the strength of beams, and presents a good deal of other useful information.

A Practical Guide to Iron and Steel Works Analyses.

By Walter Macfarlane, F.I.C. London: Longmans, Green & Company.

So important has the work of the analyst become in practically every branch of the iron and steel industries, and so delicate are the operations necessary if analysis is to give reliable data, that instructions on the subject emanating from such an authority as the Principal of the Metallurgical Department of the Staffordshire Education Committee are assured of an appreciative, if critical, audience. The notes and instructions which the author presents in this work are selections from his larger work, "Laboratory Notes on Iron and Steel Analyses." The matter contained in the latter volume was written in the first instance for the guidance of the staff in an ironworks laboratory, which was for a number of years under his supervision, and where over 40,000 estimations were annually placed on record. From this it will be gathered that the methods described are such as will be found particularly applicable to ordinary works' practice. Reliability and rapidity are essential features of methods for use under works' conditions, and as the accuracy of the methods described in this book was tested in daily practice and confirmed by outside authorities, they may be accepted with some degree of confidence. Practical application is the keynote of the whole compilation, so there need be no fear that the essential practical points have been obscured. The analytical methods are given in detail and precise quantities are stated. The instructions given by the author, if followed implicitly, should give good results, though, of course, an intelligent comprehension of the work is absolutely necessary for success. To the student who does not wish to enter for the complete analytical course, this volume should be very suitable.

PORT OF HULL ANNUAL.—We have received from the Office of "Transit," the trade journal of Hull, 10A, Bishop Lane, Hull, this Annual, edited by H. E. C. Newham, in which is presented a good deal of information on the Port of Hull and its commercial possibilities and present standing. The volume is well illustrated with photographs of the docks, shipping facilities, wharehouses, and other features.

ANDREW BARCLAY, SONS & COMPANY, LIMITED, of the Caledonia Works, Kilmarnock, have appointed Mr. W. R. Wills, Abbeyfield Road, Pitsmoor, Sheffield, as their agent for the Midland district. Among orders recently booked by Messrs. Andrew Barclay are eight locomotives, three of which are for the Port of London Authority.

Foundry Plant and Equipment.

Direct-Pouring Tilting Furnace.

A new tilting furnace of considerable interest is illustrated herewith. This apparatus has been designed by Mr. W. S. Quigley, Vice-President of the Rockwell Furnace Company New York, U.S.A., to obviate the necessity of pouring the metal from the furnace into either ladles or crucibles, and from these

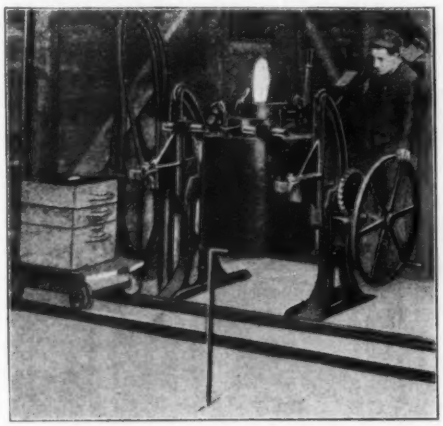


FIG. 1.—DIRECT-POURING TILTING FURNACE.

into the moulds or chills—a procedure necessitated by the design of most tilting furnaces. This second handling of the metal is objectionable, since the metal loses considerable heat during the transfer, and must be initially brought to a correspondingly higher temperature than if poured direct. The increasing use of moulding machines, too, makes it a matter of

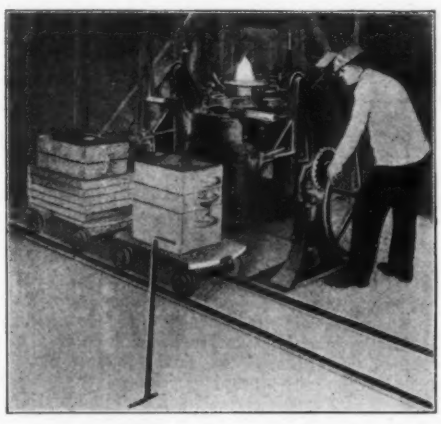


FIG. 2.—COMMENCING TO POUR FROM TILTING FURNACE.

importance to pour and handle moulds as expeditiously as possible, in order to utilise the full output of the machines.

The furnace shown herewith may be used with or without crucibles, and is fired by oil or gas. It is mounted so as to tilt or revolve about the tip of the pouring spout as a centre, so that the metal always flows from a fixed point. The entire contents of a furnace can be poured into an opening less than 2½ in. in diameter at any desired speed, and the operator can raise, lower, or lock the furnace in any position instantly.

The furnace resembles the standard tilting crucible furnace. It is mounted on trunnions, and may be

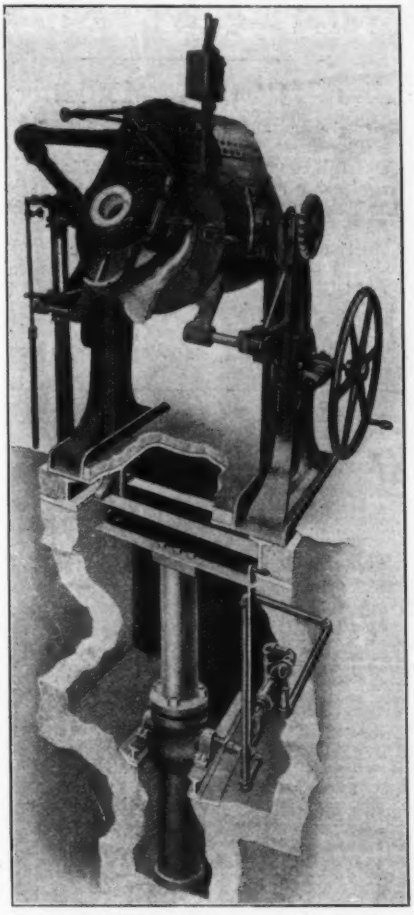


FIG. 3.—FINAL POSITION IN EMPTYING FURNACE, SHOWING ARRANGEMENT OF HYDRAULIC DEVICE.

revolved by a hand wheel like the ordinary furnace for charging, mixing, skimming, and, if need be, for pouring into a ladle or crucible, but there is an additional guide over each trunnion, and stops which prevent the furnace being tilted by hand farther than the special bearings, into which they are locked, as in Fig. 3, when ready to pour with the pouring device.

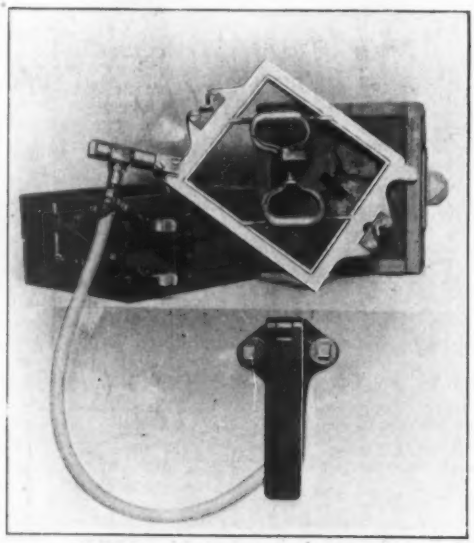
The lifting device, shown in Fig. 3, is a simple hydraulic ram, controlled in speed and direction by the hand lever in the foreground, which operates a balanced

valve regulating the flow of water into or out of the cylinder. Water under pressure is supplied by a small hydraulic pump, driven by a 2 h.p. electric motor, which will operate three to five furnaces. The pump may be belt driven from a line shaft, if preferred. The fuel, oil or gas, is conveyed to the furnace through telescopic pipes, Fig. 3, which feature permits the furnace to be operated in any position.

The switch and pressure controlling device on the panel above the motor and pump automatically maintains the pressure between 80 to 200 lbs. in the tanks shown in the background. The water exhausted from the cylinder flows back to an open tank on which the reservoir rests, and is used repeatedly. If necessary to prevent freezing 3 lbs. of calcium chloride can be added for each gallon of water, when the solution will remain fluid down to 10 degrees F., or oil may be substituted for the water.

"Simplex" Draft Moulding Frames.

A very useful apparatus, particularly for producing moulds from spray and carded patterns, is illustrated herewith. The "Simplex" draft moulding frames insure the castings being all alike, by preventing undue distortion of the mould by excessive rapping of the pattern—a feature which should be appreciated in the machine shop when the castings come to be located in jigs for machinery. The wear and tear on sprays is considerably reduced and, if a vibrator be used, virtually eliminated, as the patterns are not



"Simplex" Draft Moulding Frames.

actually touched but vibrated by means of the outside frame. It is also claimed for these frames that deep-drafted patterns can be drawn with precision in less time than it takes with loose sprays of patterns. The simplicity of the mechanical arrangement makes this apparatus a durable and practical means of producing moulds. These frames are being made in aluminium with gun-metal fittings, and are supplied with a set of standard snap flasks with the match frame accurately fitted, for hand vibrating. Where pneumatic power is already in the foundry it is recommended to employ a vibrator, as by this means the production of moulds is further facilitated and all the advantages of plate moulding are obtained. For this purpose a pneumatic vibrator with armoured hose and knee plate with operating valve is supplied by the maker of the frames, Mr. John R. Moorhouse, Ireton Road, Gipsy Lane, Leicester.

Pneumatic Sand Sifter.

The sand sifter shown herewith is claimed to be a source of considerable economy in the foundry. It is strong and substantial, to withstand the severe usage to which all such equipment is subjected, and can be operated by either steam or air, and regulated at the throttle to run fast or slow as may be desired. It is

Pneumatic Sand Sifter.

plain and simple and there is nothing complicated in the mechanism to get out of order.

The makers of this apparatus, which is claimed to do the work of 8 men, are Messrs. John Macdonald & Son, Limited, Watt Street, Maryhill, Glasgow.

The Estep Moulding Fixtures.

A simple appliance for hand-manipulated bench moulding apparatus, to facilitate drawing patterns, has been patented by Mr. E. Estep, of Sandwich, Ill., U.S.A. Fig. 1 is a sectional view of the apparatus and Fig. 2 is a bottom plan view of a pattern plate and stripping plate.

Preferably, two-part hinged snap flasks are used. The pattern plate employed is interposed between the cope and drag and has end flanges projecting beyond the sides of the flask when the parts are assembled. Each of the flanges has a hole to receive one of the dowel pins of the flask. Half patterns are formed upon the opposite sides of the pattern plate. The patterns shown in Fig. 2 are for a number of mongrel gears. The patterns and pattern plates are metal, and the former are secured to the latter by screws.

A stripping plate is used in connection with the pattern plate to bear upon the face of the sand in the flask, during the withdrawal of the patterns. This stripping plate is of the same area as the pattern plate and its body portion is cut out to fit

snugly over the drag portion of each of the patterns. Flanges are formed on the stripping plate and correspond to the end flanges of the pattern plate. The drag part of each pattern has a shank to separate it from the pattern plate, so that the full pattern protrudes through the stripping plate when the latter is in contact with the pattern plate. The stripping plate is connected to the pattern plate by bolts, which permit a limited separation, equal, if desired, to the depth of the pattern. Handles are provided

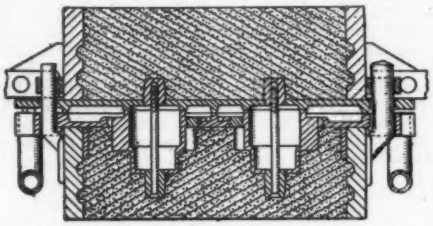


FIG. 1.—VERTICAL SECTION OF THE "ESTEP" MOULDING APPARATUS.

for lifting the pattern and stripping plates and for separating them. These handles are pivoted to the stripping plate and have cam shoulders for bearing against the face of the pattern plate to separate the plates when the handle is swung to the service position. These handles are shown at the sides of Fig. 2.

In use the flask members are assembled with the pattern and stripping plates interposed between them, and the handles in the position shown in Fig. 1, to permit the pattern plate to rest on the stripping plate, so that the pattern parts protrude through the stripping plate. The drag is then filled with sand in the usual manner, and the sand rammed against the face of the stripping plate. The apparatus is then turned over to bring the cope upper-

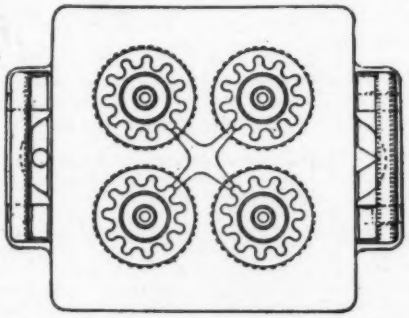


FIG. 2.—PATTERN AND STRIPPING PLATES FROM THE UNDER SIDE.

most. This is filled with sand and the sand rammed against the back of the pattern plate. The cope is now removed in the usual way, and the pattern withdrawn from the sand contained in the drag, by raising the handles. The pattern plate is separated from the stripping plate, and the latter bears upon the face or parting of the sand during this operation, and serves to prevent injury to the edges of the mould by the withdrawing of the pattern. The pattern and stripping plates are now removed, and the parts of the mould reassembled for pouring, after which the flask is removed from the mould by opening the hinged frames.

Electric Soldering Irons.

A very useful soldering iron for metal workers is illustrated herewith, the straight type and the hammer type both being shown. This tool, attached by a flexible cord to the power supply, is a very convenient one for almost any class of work. The current consumption is low, and a regular heat is obtained—both points of importance in such a tool. It is solidly

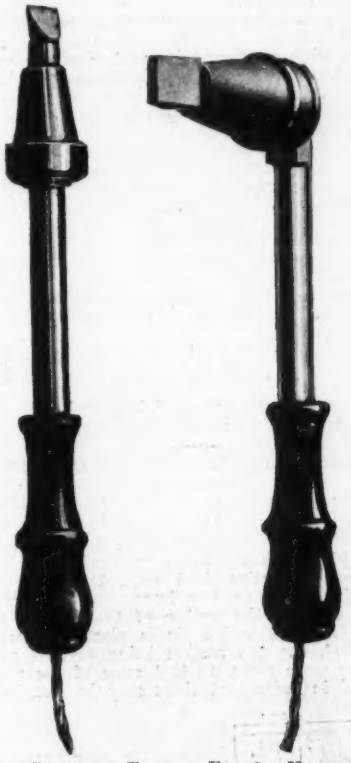


FIG. 1.—STRAIGHT TYPE. FIG. 2.—HAMMER TYPE. ELECTRIC SOLDERING BITS.

constructed, and the heating element is easily renewable, while a much longer life is claimed for the copper bit than is the case when it has to be heated by fires or flames. The various shaped bits familiar to the metal worker are made, so that the tool may meet all requirements. The makers are Messrs. Veritys, Limited, Aston, Birmingham.

Factory and Workshop Home Work Order.

We are informed by the Secretary of State for the Home Department that it is proposed to make an Order under sections 107, 108, and 110 of the Factory and Workshop Act, 1901, repealing and re-enacting the Home Work Order of the 23rd May, 1907, with the following extension:—The application of the provisions of sections 107 and 108 to—The mixing, casting, and manufacture of brass and of any articles or parts of articles of brass, and the electro-depositing of brass (including in the term brass any alloy or compound of copper with zinc or tin). The Home Secretary also proposes to make orders applying the provisions of section 116 of the Factory and Workshop Act, 1901, with modifications, to factories and workshops or parts thereof in which the making of files and iron safes is carried on.

Inventions.

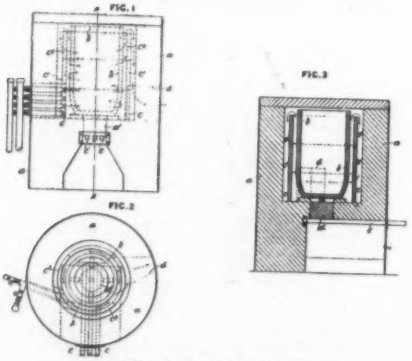
Applications for Patents.

An asterisk indicates that a complete specification accompanies the application. When inventions are communicated the names of the communicators are in brackets.

1,703.*Regenerative means for regenerating metals. B. Türke and W. Hofheimer.
1,706.*Regenerative retort furnaces. Deutsche Hüttenbau Ges.m.b.H.
1,724. Furnaces for melting, smelting, refining, etc. S. W. Price.
1258.*Producing seamless tubes. E. Sautter.
1544.*Electric furnaces. W. C. Heraeus G.m.b.H., and Carl Frenzen.
1547.*Grinding-machines. Leeds Forge Company, Limited, and R. G. Sharp.
2,483.*Automatic gear-moulding machine. G. Bruning.
2,544. Moulding-machines. A. Phillips.
2,772. Producing castings of steel, etc. A. C. Rogerson and A. F. Halstead.
2,826. Working refractory metals. (General Electric Company, United States.)
2,945. Construction of certain hollow-ware castings. T. Bamforth.
3,189. Faucet-end for wrought-iron and steel pipes and tubes. Stewarts & Lloyds, Limited, and J. G. Stewart.
3,251.*Electric furnace for treating gases. H. Pauling.
3,255.*Method of producing round steel castings. O. Bethke.
3,361.*Process of making aluminium and copper alloys. J. G. Mellen and W. F. Mellen.

Abstracts of British Patent Specifications recently accepted.

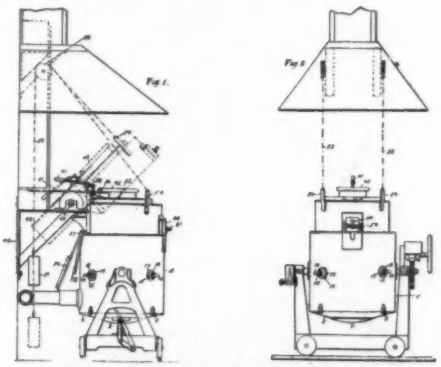
9,940 (1910). *Gas-fired Crucible Furnaces.* Fletcher, Russell & Company, Limited, and T. W. Fletcher, Palatine Works, Warrington.—Fig. 1 is a side view; Fig. 2 a plan with the cover removed; and Fig. 3 a vertical section on line A A (Fig. 1) of a cylindrical gas-fired furnace with the improvements applied. In the space between the wall *a* of the furnace and the crucible *b* a cylindrical baffle is placed in sections as *c*, c^1 and c^2, the top section being divided vertically into two or more parts, so that some of the parts may be removed in order that there may be sufficient room



Gas-Fired Crucible Furnaces.

for the clips to obtain a hold on the crucible when it is required to be lifted out. The gas jets are placed so that the flames are caused to enter by burners passed tangentially through the wall *a*, and a closed passage formed in the space between the wall *a* and the baffle *c*, and circulate first round the retort, pass over the top of the baffle c^2 and descend in a circuitous course to the outlet at *d*. The base a^1 of the furnace is formed separately and rests on bars as *e*, which can be withdrawn if found necessary to remove the bottom of the furnace from any cause, when the bottom will fall out but can be easily replaced.

2,166 (1910). *Portable Crucible Furnaces.* M. Harvey, Glebeland Works, Walsall, Stafford.—Fig. 1 is a side elevation of a portable crucible furnace constructed according to the invention; Fig. 2 is a front elevation of the same, such parts only being shewn as are necessary to illustrate the invention. The furnace proper A is made with one preferably circular metallic shell 1 carrying an annular plate 2 and ash pan 3, which latter is hinged to the annular bottom plate 2 and furnished with suitable fastenings. Fixed a short distance above the annular bottom plate 2 there is an annular plate 4, made with radial blast passages 5, through which the blast passes to the interior of the furnace at the bottom of the crucible. This annular plate 4 has an upwardly projecting rim 6 of smaller diameter than the shell 1, thus leaving an annular blast space 7 between the upwardly projecting rim 6 and the shell 1. At the top of the rim 6 there is a flange 8 which is fixed to the interior of the shell 1, above the blast inlet pipe 9, so that the annular space 7 between the rim 6 and the shell 1, together with the space within the annular bottom plate 2 and ash pan 3, forms a blast chamber from which there are any convenient number, say four, of upwardly projecting blast holes or passages 10 in the furnace lining, which communicate with tangential tuyere holes 12 in the brick lining 11, through which tuyeres 12 the blast passes to the coke in the annular space 13 round the crucible 14. So that by this means the blast is directed on to the fuel at about half way up the crucible 14 as well as through the holes 5 on to the bottom of the crucible. In the outer shell 1 there are sight or pricking holes corresponding with

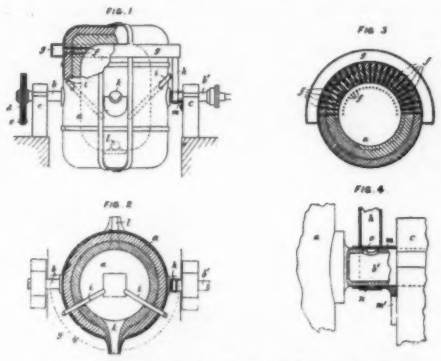


Harvey's Portable Crucible Furnace.

the tuyeres 12 and covered by suitable transparent covers 15. The blast issuing up the vertical blast passages 10, through the tuyeres 12, is regulated by suitable tuyere cocks. At the top of the furnace proper A a feed heater is provided, comprising a circular casing 28 lined with firebricks 29, and forming a continuation to, but separate from, the firebrick lining 11 of the furnace proper A, the lining 29 being carried by suitable key bricks. In this lining 29 of the extension part 28 there is a feed heater cylinder 30 which may be part of an old crucible arranged immediately above the crucible 14, and carrying the metal which is not yet melted and which is to melt and work down into the crucible. There is an annular fuel space 31 round this feed heater cylinder 30, and within the firebrick lining 29, and this space is filled with a charge of coke or other fuel, which as the fuel burns away round the crucible 14 is heated thereby and gradually falls down into the annular space 13 round the crucible, and thus no cold fuel comes in contact with the crucible 14, and the danger of the latter cracking through contraction is obviated and the life of the crucible is considerably prolonged.

26,551 (1909). *Process and Apparatus for the Production of Steel.*—H. Johnson, 7, Eyre Lane, Sheffield. Figure 1 is an elevation (partly in section); Figure 2 is a horizontal section of Figure 1; Figure 3 is a

horizontal section of the tuyere end; Figure 4 is an enlarged section of a detail. The converter is preheated in the ordinary way, and tilted or rotated into a horizontal position with opening *k* uppermost, the tapping hole or holes being closed. The molten metal is drawn from a cupola or mixer, and poured through the opening *k* into the converter. The converter, when charged, is then rotated to a vertical position with the molten metal in that end which is fitted with the tuyeres *f*, the air blast being admitted as soon as the vertical position has been reached. Preferably, the admission and stopping of the air blast is accomplished automatically by a device such as that shown in Figure 4, so that the starting and stopping of the air blast is more or less gradual. The molten metal remains under the action of the tuyeres *f* until the bulk of the impurities are eliminated. When the required degree of purity has been attained, the converter is rotated into an inverted position, as shown in Figure 1, the air being cut off from the tuyeres. The end of the converter which now contains the charge has been preheated by the hot gases given off during the previous operation, and to regulate this an

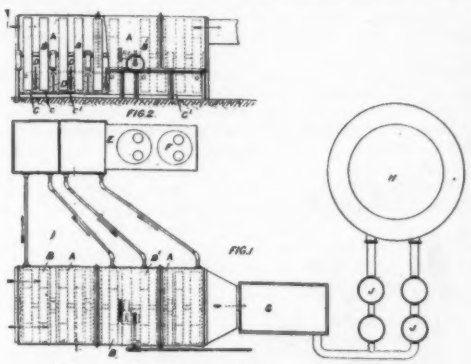


Apparatus for the Production of Steel.

additional closable outlet may be provided for the escape of the hot gases. The electrodes *i* are now brought into position and the current switched on, any suitable number of electrodes being employed and the current being either direct or single-phase or multiphase alternating. On the completion of the electrical refining, the current is switched off, and the contents of the converter are removed either by tapping the metal at *l*, leaving the slag behind, or by first removing the slag through the opening *k*, and then rotating the converter to a horizontal position so as to pour out the metal through the opening *k*. It is not necessary that the electrodes should be introduced through the side wall of the converter, as they may be introduced through the bottom.

26,588. (1909). *Process of Refining Steel.*—Société Anonyme Electrometallurgique (Procédés Paul Girod), of Ugine (Savoie), France. Metal is treated in a Thomas converter until a sample shows it to contain about .10 to .15 per cent. of carbon; .1 to .2 per cent. of silicon; .2 to .3 per cent. of manganese and phosphorus, the quantity of which varies according to the purity of the cast iron employed, but which may vary between .025 to .030. The metal is run into an electric furnace at a temperature of 1,500 to 1,600 degrees C. It is then allowed to cool, and on cooling it will be noticed that an evolution of gas occurs due to the action of the carbon upon the retained oxide. There will also be seen at the surface of the bath, slag formed by the action of the manganese and silicon upon the retained protoxide of iron. This evolution of gas, which at first is accompanied by a boiling of the metal, decreases as the temperature falls. If the proportion of carbon silicon and manganese retained by the metal was sufficient the metal will have been freed from the oxides by the carbon, manganese and silicon poly-silicates of iron and manganese being produced. The phosphorus is acted upon by the oxide of iron. When the bath has become sufficiently quiescent and the temperature sufficiently low for such occluded gases as hydrogen and nitrogen to pass away, the surface of the metal is covered with slag preferably consisting of lime, silicon and a flux especially calcium fluoride; the metal is then reheated. When quite fluid the slags, comprising silicates of manganese and iron and therefore non-oxidising, rise to the surface where they are absorbed by the slag.

28,099 (1909). *Drying of Air for Supply to Metallurgical Furnaces.* J. Bliss, Peru Street, Broughton, Manchester.—Fig. 1 is a diagrammatic view showing the combination of an air-cooling or drying apparatus with a blast furnace; Fig. 2 is a sectional side view of the cooler. In combination with a metallurgical furnace one or more rotary coolers are employed of the type having rotating plates, discs, cylinders, or other rotating parts, each portion of which is adapted during a part of each revolution to dip into a tank containing liquid and during the remainder of the revolution to be presented to the air supplied to the furnace. A is an air cooler, comprising a number of rotating cylinders B formed of spirals of sheet metal, rotating in a tank of water C, and a second series of similar cylinders B^1 rotating in a tank of brine C^1. The tanks C C^1 are divided into separate compartments *c* c^1 preferably so arranged that all the water or brine flows from one end

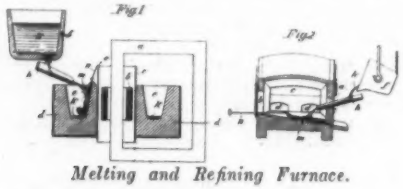


Drying Air for Supply to Metallurgical Furnaces.

of each tank to the other through all the compartments. The partitions D between the compartments *c* c^1 are arranged so that the liquid flows alternately over and under them, so that all the water flows through each compartment and it cannot become stagnant in any compartment. The water and brine for the cooler are preferably circulated through a refrigerator E cooled by suitable refrigerating machinery F, and the air is preferably led into the cooler at that end at which the water or brine is warmest so that the air as it is gradually cooled by passing through the cooler is acted on by cooler liquid at each cylinder B or B^1 of the cooler. The air is drawn through the cooler A and forced to the blast furnace H by a suitable blowing engine G, though the air may, if found desirable, be also driven forward to the cooler by fans arranged in the duct leading to the cooler. Between the blowing engine G and the furnace H the air is passed through suitable heating apparatus J such as a Cowper stove.

5,267 (1910). *Melting and Refining Furnaces.* Firm Poldihütte Tiegelgusstahlfabrik, Landskrongasse 1, Vienna, I., Austria.—Figure 1 is a vertical section showing a Kjellin electric induction furnace being charged with liquid metal, and illustrating the invention. *a* is the yoke of the magnet, *b* the primary winding, *c* a cooling jacket, *d* the refractory brickwork of the furnace, and *e* the melting or refining chamber. *f* is a casting pan from which the molten metal is poured into the Kjellin furnace through a short channel *h*. The molten metal is indicated at *k*. A plate-like body *m*, which in

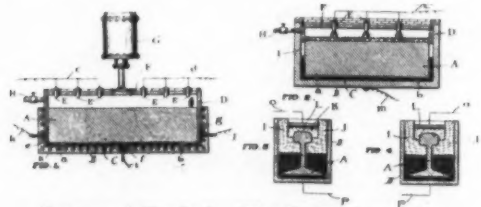
the example under notice, consists of a perforated iron plate of suitable form, coated with refractory material, is suspended in the melting gutter *e* from the point *o* by the hook *n*. Figure 2 is a vertical section showing an ordinary Martin furnace being charged with liquid metal. *a* is a small door for charging, *b* the normal working door of larger size, *c* the air inlet, *d* the gas inlets,



Melting and Refining Furnace.

and *f* a ladle from which the metal is charged into the furnace through the short channel *h*. *k* indicates the liquid metal and *m* a plate-like body that is simply laid on the bottom of the furnace chamber, and which can be drawn out of the furnace, after the same is charged, by means of the rod *n*.

3,061 (1910). *Processes of Hardening Metallic Surfaces of Iron or Steel or Alloys.* J. H. Reid, 354, Mulberry Avenue, Newark, New Jersey, U.S.A.—The objects of the invention are to provide a simple process by means of which an increased degree of surface hardness may be obtained in a minimum time, and also to combine with the process a method of gradually annealing or softening the metal below the surface in proportion to the distance therefrom, thereby forming a hardened surface with a gradually softened or annealed backing. In carrying out the process, the plate is bedded in suitable granular conducting material, such as hematite, magnetite or carbon in the form of coke, a bath of hardening substances is formed on the surface and an electric current passed through the bath, plate, and bed.

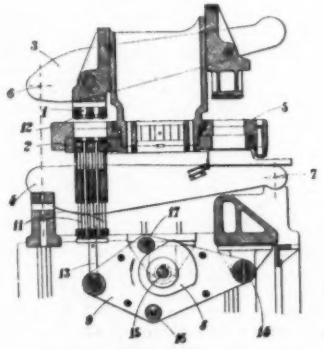


Process of Hardening Metallic Surfaces of Iron or Steel or Alloys.

The granular material offering resistance to the flow of the current is raised in temperature, heating the lower part of the plate and annealing the same, while the hardening materials contained in the bath, which may be vanadium, tungsten, or molybdenum in the form of the metals themselves or their chlorides, combine with the surface to harden the same. Fig. 1 is a vertical section through one form of apparatus for treating armour-plates; Fig. 2 is a vertical section through an alternative form; Fig. 3 is a transverse section through a modified form adapted to treat rails to harden the tread surface; Fig. 4 is a similar view to Fig. 3 in which a bath of granular substance is employed.

17,382 (1909). *Carburization of Steel.* C. A. Keller, 3, rue Vignon, Paris.—In order to effect the carburization, a prismatic block of strongly compressed agglomerated carbon is suspended to a cable wound on a winch or on any other suitable hoisting apparatus, and on the cable or on the hoisting apparatus a balance is arranged so as to enable the weight of the charge suspended to be determined at any moment. The prism is furnished with an iron block so as to increase its weight, and it is then introduced into the furnace through an opening made for the purpose in the arch. Owing to the weight of the iron block the carbon prism can pass through the layer of slag and penetrate into the metal bath, where it becomes absorbed. As the carbon is absorbed, the weight suspended decreases, and as the weight of the molten metal constituting the metal bath, into which the carbon block is immersed, is known, it is easy, by watching the decrease of the weight shown by the balance, to regulate the carburization, and to stop it exactly at the moment when the desired proportion of carbon has been absorbed, by raising the carbon block by means of the hoisting apparatus.

2,731 (1910). *Briquetting Presses.* Société Leflaive et Cie, of la Chaléassière, St. Etienne, Loire, France.—The accompanying cut shows a form of construction in accordance with the invention applied to a press of the Couffinhal type. The machine comprises two compression plungers 1 and 2, pivoted to two beams 3 and 4 which oscillate around shafts 6 and 7, and are operated from a driving engine by means of suitable transmission mechanism. The moulds, which are located in a rotary table 5, successively come into position in front of the compression plungers 1 and 2, in the lower one of which pins or rods 11 are adapted to slide, the pins being received at the moment of compression in apertures 12 in the upper plunger 1. The pins 11 are mounted on a rod 13, pivoted at the end of a lever 9, which can oscillate around a shaft 14, mounted upon the frame of the machine. The operation of the lever 9, and consequently of the pins 11, is effected by means of a cam 8 mounted upon a shaft 15, which is continuously rotated by the driving engine in the direction shown by the arrow, the lever 9 being provided with



Improved Briquetting Press.

two rollers 16 and 17, which engage with the edge of the cam 8. In the operation of the device, when the material is in the mould and just before the movement of the compression plungers takes place, this being the position shown in the drawing, the lever 9 is raised by the cam 8, so that an upward movement of the rod 13, carrying the pins 11, is effected. This causes the pins to penetrate into the material and form holes before the compression has taken place. The moulding plungers 1 and 2 are now brought together by the operation of their supporting beams 3 and 4, and compress the material. The cam 8, acting upon the roller 16, then causes the lever 9 to descend so as to withdraw the pins 11, and the two plungers separate so as to liberate the moulded briquette. The table 5 is immediately subjected to an angular displacement which brings the next mould into position between the compressing plungers, and the sequence of movements is repeated.

Mr. R. H. Ellacott, sole proprietor of the business of Messrs. Ellacott & Sons, of the Plymouth Foundry and Engineering Works, Great Western Docks, Plymouth, died recently, aged 59 years.

Industrial Training

Guildhall Conference.

At the Guildhall, London, on Tuesday, February 28, under the presidency of the Lord Mayor, Sir T. Vezey Strong, a Conference was held for the purpose of organising and promoting a movement which has for its object the training of children for useful vocations at the close of the school period. The Conference was organised by a special committee of the elected representatives of the chief associations of employers, workers, and educational authorities, and includes nearly 100 members of Parliament, members of County Councils, trades councils, representative trade unionists, members of co-operative societies, prominent educationists, and representative private individuals who have concerned themselves with the training and education of young people.

The Lord Mayor, in opening the proceedings, said in view of the importance of the subject they were met to discuss, he had written a letter to Sir Arthur Bigge, with a request that it might be submitted to the King. In reply, he had received the following communication from Sir Arthur Bigge :—

"I am commanded by the King to convey to you the expression of his sympathy with the objects which your Conference desires to secure. His Majesty believes a further development of industrial training will be of inestimable benefit to the nation, and he hopes that your Conference may have the effect of stimulating and educating public opinion in favour of this branch of education."

The object of the Conference, continued the Lord Mayor, was to secure the deepening and broadening of the foundations of the national prosperity by training the children for useful vocations. From that day forward school life and after life would be better assimilated. The true dignity of labour would be better appreciated and more thoroughly upheld. They desired an emphatic declaration on the question of ensuring that henceforth the national system of education should include practical instruction leading up to or qualifying for useful vocations. If the need was declared the means would be forthcoming. Mr. Asquith and Mr. Balfour had written in reply to his invitation.

Mr. Asquith, in his letter, said that he believed this question to be one of the highest importance to the national welfare, and should welcome any suggestion that would lead to its solution.

Mr. Balfour wrote expressing his sympathy with the movement, and said he was certain that the interchange of opinions which the Conference will produce will be of the utmost value to the educational and social welfare of the country.

The following resolution was proposed :—"That this Conference views with grave concern the large number of children annually leaving school without practical training for definite vocations, and that a national system of industrial, professional, and commercial training should be established, to which the children shall pass as a matter of course (unless the parents are prepared to undertake their future training), and without interval, for a definite period, to be thoroughly trained for entry to the particular calling for which they are best fitted, such training to be under fully qualified instructors. That the Government be urged to provide by legislation such a complete system of training, free to all scholars, and the expenses thereof defrayed from the National Exchequer."

Lord Brassey said the prosperity of the country depended mainly on the number of the skilled workers in its various industries. He was himself the son of a great captain of industry, who, as one that had succeeded in a strenuous career, was often asked for advice as to the best way to bring up sons. His father's reply to such questions was always the same —'Teach your boy a trade." They should do their best to encourage parents to resist the temptation to supplement their wages by the earnings of their children at an early age, and endeavour to get them to have the children taught trades.

Sir John Gorst declared that a satisfactory state of affairs would only be reached in this direction when attendance at continuation classes was made compulsory by legislation.

Mr. W. A. Appleton seconded the resolution, and supported the compulsory technical training of young people.

Sir Swire Smith, while declaring himself in favour of technical training, proposed an amendment declaring that the Government should provide the cost of such training, and that all boys and girls should be required, during a portion of each year until the age of 18 years, to attend continuation schools in such subjects as applied art, science, and commerce.

Lord Hugh Cecil, M.P., thought they would be making a mistake if they committed themselves too hastily to any scheme of compulsory training under universal State management, or to any system of compulsion at the present stage. Such a system, if embarked upon at once, would be certain to excite great opposition among the working classes, and he thought they should first try what they could do without compulsion.

Sir George Reid said what was needed in a movement of this kind was to find a few people really full of enthusiasm to devote themselves to its promotion, and make it a success.

The amendment was put to the meeting, and defeated, and the resolution was then adopted by a large majority.

On the motion of Mr. Applegarth, seconded by Sir George Kekewich, a National Industrial Education League was then declared to be formed, and a committee was appointed.

Deaths.

The death is announced of Mr. J. W. Callaghan, of Messrs. Callaghan, Ross & Company, edge-tool makers, etc., of Dundee.

Mr. J. Wylie Nisbet, M.I.Mech.E., chairman of the Junior Institute of Engineers, and one of the managers of Messrs. John Aird & Sons, died at his home, in Putney, London, S.W., on Feb. 20, at the age of 42 years.

Mr. L. Marsden, of the firm of Marsden & Beeten, steel manufacturers and merchants, Sheffield, died recently in his sixty-third year. The deceased's first business experience was in connection with Robert Marsden & Company, of the Broughton Lane Rolling Mills, but about forty years ago he started in the steel and file business. Later he went into partnership with his brother-in-law, Mr. P. N. Beeten, and they had carried on business together since.

We regret to record the death on February 3 of Mr. George Coates Whitwell, who was well known in commercial circles on Tee-side. He was 68 years of age, and was a younger brother of the late Alderman William Whitwell and the late Mr. Thomas Whitwell. About 40 years ago he was in business at Middlesbrough as an iron merchant, and 30 years ago joined the Board of Directors of Messrs. William Whitwell & Company, Thornaby Iron Works, Thornaby-on-Tees, of which firm in recent years he has been managing director.

Trade Talk.

MR. E. C. HOLDEN, consulting engineer, has removed to 23, Acresfield, Bolton.

THE RUSTLESS IRON COMPANY, of Keighley, Yorks, are building works at Lawkholme Lane.

H. R. MERTON & COMPANY, LIMITED, have removed to Billiter Buildings, Billiter Street, London, E.C.

THE PEARLITE STEEL COMPANY (1910), LIMITED, have removed to Pearlite Steel Works, Royds Mill Street, Sheffield.

THE offices of Mr. T. W. How, consulting engineer, have been removed to 17, Victoria Street, Westminster, London, S.W.

MR. D. SMITH, engineer and ironfounder, Raglan Street, Wolverhampton, notifies a supplemental dividend of 1¼d. in the £.

THE London offices of the United Brassfounders and Engineers, Limited, have been removed to 57 and 58, Leadenhall Street, E.C.

PROFESSOR J. O. ARNOLD lectured at the Sheffield University on February 18 on "The Metallurgical Work of Henry Clifton Sorby."

MESSRS. JOHN BOWLING & COMPANY have removed from the Union Foundry, Hunslet Road, to Castleton Foundry, Armley, Leeds.

MR. S. ROBERTS, of Sheffield, introduced a Bill into the House of Commons, on February 14, to amend the Old Metal Dealers Act, 1861.

ENGINEERING INSTRUMENTS, LIMITED, Skerne Works, Darlington, have appointed, as their Scottish agent, Mr. R. Steel, 38, Bath Street, Glasgow.

MR. THOMAS ASHBURY, consulting engineer, has removed his offices from 17, St. Ann's Square, Manchester, to Ash Grove, Victoria Park, Manchester.

MESSRS. TROUP, CURTIS & COMPANY, engineers, Victoria Dock Road, London, E., have established a branch at West Bute Street (Docks), Cardiff.

THE REASON MANUFACTURING COMPANY, LIMITED, have appointed Messrs. Davidson & Blackadder, 50, Wellington Street, Glasgow, as their agents for the whole of Scotland.

MR. W. H. COWARD, engineer and machinery merchant, trading as W. H. Coward & Company at the Railway Iron Works, Railway Place, Bath, notifies an intended dividend.

MESSRS. J. H. MACLAREN, and J. A. GROOME, carrying on business as electrical and mechanical engineers under the style of MacLaren & Groome, Harrow, have dissolved partnership.

MESSRS. E. HALL and R. T. LORD, carrying on business as ironfounders, at Banktop Iron Works, Foundry Street, Oldham, under the style of Hall & Lord, have dissolved partnership.

THE TOURTEL GAS AND GENERAL ENGINEERING COMPANY, LIMITED, is being wound up voluntarily, with Mr. H. V. Askham, 57, Chiswell Street, London, E.C., secretary, as liquidator.

MESSRS. F. G. PEARSON & COMPANY, edge tool manufacturers, of Furnace Hill, Sheffield, have acquired the business of Messrs. James Wall & Company, edge tool manufacturers, Sheffield.

A BRITISH branch of the Dominion Abrasive Wheel and Supply Company, Limited, Toronto, Canada, has been established in Birmingham, offices having been taken at 198, Corporation Street.

A MEETING of the shareholders of the Engineering Undertakings, Limited, will be held at 67, Mosley Street, Manchester, on March 20, to hear the liquidator's report on the winding up of the company.

A PAPER on "Electric Steel Furnaces" was given by Messrs. C. Chappell and F. Hodson before the Students' Engineering and Metallurgical Society at the Department of Applied Science, Sheffield University, recently.

THE RAGLAN FOUNDRY, Gibson Street, Bradford, lately in the occupation of Messrs. J. & T. Clark, ironfounders, will, together with the plant and machinery, be offered for sale by public auction on Thursday, March 16.

WOODS & COMPANY (STOWMARKET), LIMITED, Suffolk Iron Works, Stowmarket, have appointed Messrs. Ratcliffe Bros., of 8, Mason's Avenue, Basinghall Street, London, E.C., as their London representatives for castings.

BENJAMIN JOHNSON & SON, LIMITED, Mill Lane Works, Bramley, near Leeds, closed down on February 4. The company is a private one, but it is not anticipated that the stoppage will be other than of a purely temporary nature.

MESSRS. WILLIS, STEWART & COMPANY, 65, New Broad Street, London, E.C., have been appointed London agents of Samuel Osborn & Company, Limited, and George Turton, Platts & Company, Limited, both of Sheffield.

A FIRE broke out on February 17 at the Victoria Foundry, Dundee, belonging to Messrs. Chas. Parker, Sons & Company. The damage was not heavy, the outbreak being confined to the joinery and pattern-making shop.

THE NORTH BRITISH RAILWAY COMPANY have arranged with W. & T. Avery, Limited, Birmingham, for the maintenance in efficient working condition of the weighing apparatus on that system, and also for the supply of new weighbridges.

IT is officially announced that the Old Foundry, Burry Port, has been transferred to a Lancashire firm of iron and steel founders, and the preparations for the re-opening of these buildings, which have been closed down for over 20 years, are complete.

THE Heroult electric furnace plant, which has been building for some time at the works of Vickers, Sons, & Maxim, Limited, Sheffield, has been successfully started. The plant at Braintree for Messrs. Lake & Elliott has also been put into operation.

THOMAS BROADBENT AND SONS, LIMITED, of the Central Iron Works, Huddersfield, who have taken up the manufacture of furnace charging machines, have received their first order from the Grovesend Steel and Tinplate Company, Limited, Gorseinon, Glamorganshire.

NOTICE is given that the names of the undermentioned companies have been struck off the register, and such companies are dissolved:—Conduits and Fittings, Limited, Hydrogen Steel Syndicate, Limited, and the Malleable Steel Castings Company (1906), Limited.

A MEETING of the Glasgow and West of Scotland Association of Foremen Engineers and Draughtsmen was held on February 11 in the Hall, 39, Elmbank Street, Glasgow, when Mr. George Watt, Dumbarton, read a paper on "Moulding from a Practical Point of View."

MESSRS. G. WILLIAMSON and J. W. CONNELL, carrying on business as general ironfounders, at Waterloo Foundry, 205, Jack Lane, Hunslet, Leeds, under the style of Williamson & Connell, have dissolved partnership. Mr. G. Williamson will continue the business in his own name.

HADFIELD'S STEEL FOUNDRY COMPANY, LIMITED, Sheffield, have recently, through their representatives at Kristiania, Messrs. C. S. Christensen & Company, presented the new Technical College, at Trondhjem, with an ore-breaker. The apparatus is to be installed in the laboratory of the College for mining and separation.

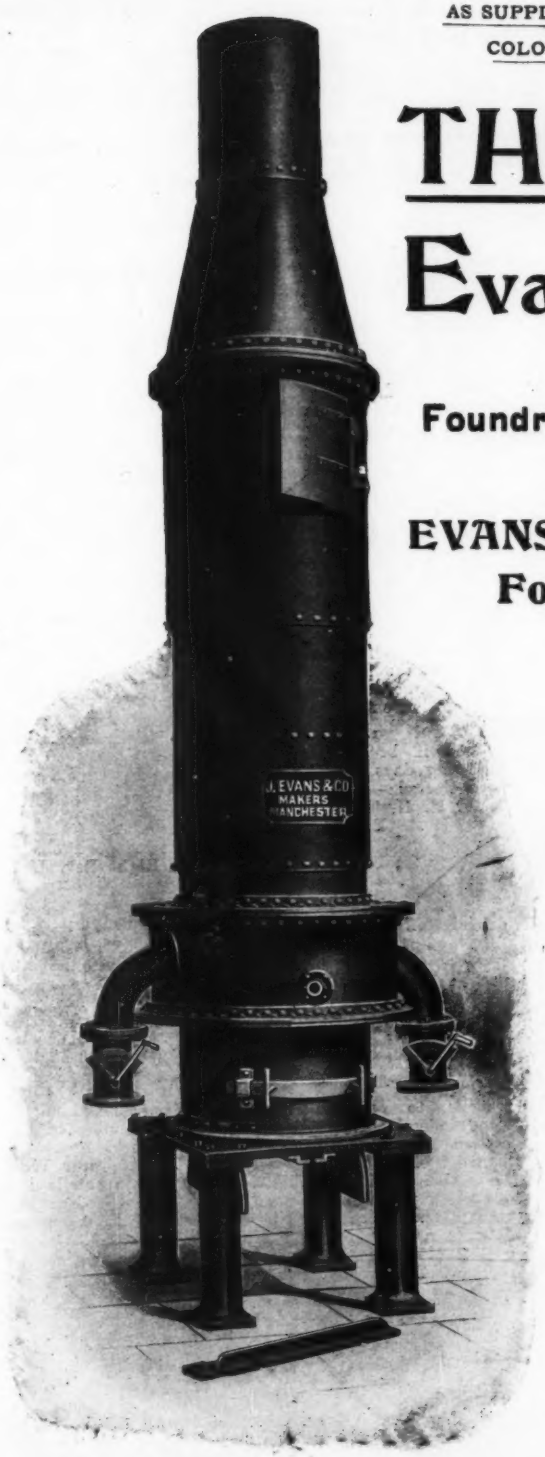
MR. W. I. TAYLOR, a director and London and South of England agent of Clarke, Chapman & Company, Limited, has severed his connection with the firm. In conjunction with his sons he will in future carry on business under the style of W. I. Taylor & Sons, as London managers for the Darlington Forge Company, Limited, at 70, Fenchurch Street, E.C.

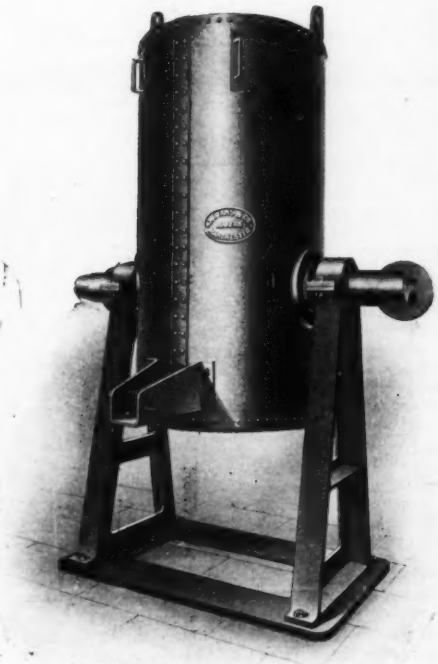
AS SUPPLIED TO THE ADMIRALTY, WAR OFFICE,
COLONIES, AND FOREIGN GOVERNMENTS.

THE Cupola.
Evans's Rapid.

Foundries Completely Furnished.

EVANS'S NEW CUPOLETTE
For Emergency Work.





Telegrams: "LADLES, MANCHESTER."

James Evans & Co.,
Britannia Works,
Blackfriars,
MANCHESTER.

Mr. Victor Parker, secretary to Palmers Shipbuilding and Iron Company, Limited, Jarrow, has issued a notice to the "B" shareholders, stating that a call of 3s. 4d. per share has been made on the "B" shares of the company, and that it has been resolved that such call should be payable in two equal instalments of 1s. 8d. each on April 10 and June 10.

The London Sherardizing Company, Limited, the Western Sherardizing Company, Limited, the Sheffield Sherardizing Company, Limited, and the Birmingham Sherardizing Company, Limited, are all being wound up voluntarily under the provisions of the Companies (Consolidation) Act, 1908, with Mr. C. J. Bush, of 6, Great Winchester Street, London, E.C., as liquidator.

Mr. John Roe, who for many years has been works manager's assistant at the works of A. Handyside & Company, Limited, has just left that firm, and is starting a new foundry in Derby, in conjunction with Mr. James Harrison, who, for upwards of 30 years, has been foundry foreman at Messrs. Handyside's. The title of the new firm will be Roe & Harrison, Limited, Globe Foundry, Stores Road, Derby.

Monks, Hall & Company, Limited, of Warrington, have made arrangements with Messrs. J. B. Guthrie & Son to give up the agency which they have held for upwards of 28 years, in order that Messrs. Monks may open an office in London under their own name and management. Mr. Frank Cox has been appointed their London representative, and commenced his duties on February 1 at St. Benet Chambers, Fenchurch Street, E.C.

The conditions in respect to the Lewis Prizes, 1911, offered by the South Wales Institute of Engineers, have just been issued. Prizes of £10 and £5 are offered. The Council also draw attention to the scholarship in engineering offered by the Institute of £70 per annum, tenable for three years at the University of South Wales and Monmouthshire. The examination will be held in the University College, Cathays Park, Cardiff, commencing Friday, April 21.

In the Chancery Division, on Feb. 3, Mr. Justice Swinfen Eady appointed a receiver of Moorwood, Sons & Company, Limited, ironfounders, and, all parties consenting, gave judgment in a debenture-holder's action—Duffield *v.* the Company. The plaintiff held the whole of a first series of debentures, amounting to £25,000, issued twelve months ago. The company had passed a resolution to wind up voluntarily, and that was one of the grounds for maturing the debentures.

Notice is given that the names of the undermentioned companies have been struck off the register, and such companies are now dissolved:—Almaden Antimony and Lead Mining Company, Limited; Ball Chain Company, Limited; Eagle Edge Tool Company, Limited; Electrical Castings and Engineering Company, Limited; Jamison Steel Company, Limited; Manganese and Iron Syndicate, Limited; Phelps's Metal, Limited; Shillingford Engineering Company, Limited; Simpson Engineering Works, Limited; Strathern's Weldless Chains, Limited; and the Weldless Stamped Chain Syndicate, Limited.

The public examination in bankruptcy of Harry Horton and Edward Wilhelm Richard Langenberg, trading as the United Malleable Casting and Engineering Company, at Foundry Lane, Wellington, Salop, was held at the Shrewsbury Bankruptcy Court on February 14. The gross liabilities were estimated at £1,733 13s. 11d., of which £1,732 7s. 2d. is expected to rank, and the assets are put at £282 4s. 3d., leaving a deficiency of £1,451 9s. 8d. Horton was formerly a draughtsman employed by the United Electric Car Company, Preston, and Langenberg was an electrical engineer, employed by Messrs. Maddox & Clay, Oakengates. On the suggestion of Langenberg, it was arranged to form the company. Neither had any capital, but Mr. Wm. Garner, of West Bromwich, advanced £500, and also became security for £300, and Horton's wife deposited a bond for £600. A beginning was made in April last, but in September the firm found themselves in difficulties, being short of working capital. On December 15 the firm were served with a writ by the Lilleshall Company which was satisfied by a sale on January 12, and the creditors filed a petition in bankruptcy against the firm Horton stated that Langenberg had sole control of all the monies received. Debtor presented a statement which showed that the contracts executed only amounted to £251 16s. 1d. The Registrar granted an application for a warrant to issue against Langenberg, and the examination of Horton was formally adjourned.

Personal.

Mr. J. T. McCleary has been elected secretary of the American Iron and Steel Institute.

Mr. Cecil Grenfell, of London, has accepted the chairmanship of the board of the Southern Iron & Steel Company, U.S.A.

The late Mr. J. Payne, of the Vauxhall Iron Works, Bedminster, Bristol, left estate valued at £38,270 gross, with net personalty £37,174.

The late Mr. J. Parkinson, of Messrs. J. Parkinson & Son, Canal Ironworks, Shipley, Yorks, left estate valued at £26,468 gross, with net personalty £24,290.

Mr. Edward Miller, employed at the offices of Richard Hill & Company, Limited, Middlesbrough, for many years, has been appointed secretary of the company.

Mr. J. A. Farrell took office as President of the United States Steel Corporation on February 1. It is interesting to state that one incident in connection with Mr. Farrell's appointment was a cablegram from Mr. Charles M. Schwab, who was in London at the time, and who was the first President of the Corporation. This cable was sent to Judge Gary, and complimented the Corporation on its wise selection.

For this year's meeting of the British Association, which will be held at Portsmouth on August 30 and following days, the following sectional Presidents have been elected:—Mathematical and physical science, Professor H. H. Turner; chemistry, Professor J. Walker; geology, A. Harker; economic science and statistics, the Hon. W. Pember Reeves; engineering, Professor J. H. Biles; educational science, the Right Rev. J. E. C. Welldon.

Further changes are reported in regard to the official staff at the works of Palmers Shipbuilding and Iron Company, Limited. Mr. Victor Parker is to be removed to London, and the position of secretary will become vacant. It is understood that Mr. Calderwood is to be succeeded by Mr. Fleming, of Clydebank, as manager of the blast furnace and steel works department. Mr. Calderwood has accepted an appointment with Messrs. Bolckow, Vaughan & Company, Middlesbrough.

Mr. H. Winterton, who has been for many years traveller to William Cumming & Company, Limited, ironfounders' furnishers, and who is a member of the British Foundrymen's Association, has been appointed manager of the firm's new mills at Albion, near West Bromwich. At these mills the company are now laying down new plant for the manufacture of standard quality facings and other moulding materials. Arrangements have been made whereby Mr. Winterton, while taking control of the new factory, will be able to continue to represent the firm on the road.

Mr. J. W. Seaver, mechanical, consulting and contracting engineer, died recently in Cleveland, U.S.A. After occupying a number of important positions, the deceased gentleman became connected with the Wellman-Seaver-Morgan Company, of which company he was the vice-president. After 10 years spent in this connection, Mr. Seaver opened an engineering office in Cleveland with Mr. J. E. A. Moore, and continued in this work until his death.

SOUND

STRONG, CLOSE-GRAINED

CASTINGS

Obtained by using

"TITANIUM THERMIT"

TINS READY FOR USE. **ALL SIZES from 2 cwt. to 20 tons.**

Prices and Particulars from

THERMIT LIMITED,

Telegrams: "FULMEN, LONDON."
Telephone: 3749 Central.

27, Martins Lane,
Cannon Street, E.C.

Works: **210a, Bow Rd., E.**

ELDERS FOUNDRY COKE

AS SUPPLIED TO THE BRITISH ADMIRALTY DOCKYARDS.

The following, selected from numerous letters, are eminent testimony as to the quality of our celebrated "A.A.A." Coppee Foundry Coke, carefully selected, and despatched in sheeted wagons.

From PECKETT & SONS, Bristol.

Bristol, October 25th, 1904.

We have been using your Selected Foundry Coke for some considerable time.
We have pleasure in stating that we are very pleased with it, as we find we get sounder and cleaner castings, mor. free from blowholes and other defects, than we formerly did.

From BOW, McLACHLAN & CO., LTD. (Paisley Foundry), Paisley, Glasgow.

Paisley, 12th March, 1909.

We have yours of 4th inst., and in reply have pleasure in stating that we have been using your Foundry Coke for several years for special purposes with highly satisfactory results.

Elders Collieries, Ltd., Cardiff.

PRICES OF METALS.

The following table shows the approximate latest prices and position of stocks of metals during the past two years :—

Metals.	End Feb., 1911.	End Feb., 1910.
Iron—Scotch pig warrants ton	..... *54 9	..... 57/1½
—Middlesbro' warrants ... ton	..... 48/8½	.... 51/3
—W.C. M/nos Bessemer ... ton	..... 68 0	.... 66 0
—Stock, Scotch ... ... tons	 1,000	 1,000
Copper—Chili bars, GMB ton	..... £54 15 0	..... £59 5/0
—Stock, Europe and afloat tons	..... †82,387	.... †113,455
Tin—English ingots ... ton	..... £187 10 0	..... £150 10/0
—Straits ... ... ton	..... £189 10 0	..... £151 7/6
—Stock, London, Holland, U.S.A., and afloat ...tons	... . †17,556	 22,373
Lead—English pig ... ton	..... £13 12 6	..... £13 5/0
Spelter—Ord. Silesian ... ton	..... £23 0 0	..... £23 3 9
Quicksilver (75lb)... bottle	..... £10 0 0	..... £9 10 0
Antimony—Regulus ... ton	£32 0 0 £35 0 0	..... £30 9 0

* Settlement price. † February 28.

CASTINGS.

In the Cleveland district the following are the nominal rates current for castings :—

	£ s. d.		£ s. d.
Columns (plain)	6 10 0	to	6 15 0
Pipes, 1¼ to 2½ in.	4 17 6	to	5 2 6
,, 3 to 4 in.	4 10 0	to	5 0 0
,, 5 to 8 in.	4 7 6	to	4 10 0
,, 10 to 16 in.	4 7 6	to	4 10 0
,, 18 to 24 in.	4 7 6	to	4 10 0
Chairs	3 12 6	to	3 15 0
Floor plates (open sand)	3 0 0	to	3 5 0

SCRAP.

The quotations for scrap, subject to market fluctuations, are as follows :—Heavy wrought (mixed), £2 10s. 0d.; light wrought, £1 7s. 6d.; heavy cast, £2 7s. 6d.; all per ton, f.o.b., London. Copper (clean), £51 10s. 0d.; brass (clean), £38 0s. 0d.; lead (usual draft), £12 5s. 0d.; zinc, £18; all per ton delivered merchant's yard.

Dominion Abrasive Wheel and Supply Company, Limited.—Capital £5,000 in £1 shares.

Birchall Manufacturing Company, Limited.—Capital £10,000 in £1 shares (5,000 preference), to carry on the business of manufacturers of and dealers in all kinds of small wire and metal goods, etc. Registered office: Bradford Street, Birmingham.

Watlington & Company, Limited.—Capital £5,000 in £1 shares, to acquire the business carried on by V. Watlington, J. F. Caine, and S. C. Hackney, and to carry on the business of electrical and mechanical engineers, etc. Registered office: Moorgate Street Chambers, E.C.

New Companies.

Thomas Perry & Son, Limited.—Capital £50,000 in £1 shares, to carry on the business of ironfounders.

Wm. Hodgson & Sons, Limited.—Capital £3,000 in £1 shares, to carry on the business of weighing machinists.

Frederick Usher and Company, Limited.—Capital £1,000 in £1 shares, to carry on the business of ironfounders, &c.

Alchemy Trust, Limited.—Capital £100 in £1 shares. Registered office: 2 and 3, West Street, Finsbury Circus, E.C.

Alchemy Alloys, Limited.—Capital £100 in £1 shares Registered office: 2 and 3, West Street, Finsbury Circus, E.C.

Alchemy Metals, Limited.—Capital £100 in £1 shares. Registered office: 2 and 3, West Street, Finsbury Circus, E.C.

Michael Pal & Company, Limited.—Capital £5,000 in 4,000 preferred shares of £1 and 4,000 deferred of 5s., to carry on the business of engineers.

William Esplen, Son, & Swainston, Limited.—Capital £1,000 in £1 shares, to carry on the business of consulting and superintending engineers, etc.

London Malleable Castings Company, Limited.—Capital £20,000 in £1 shares (15,000 preferred and 5,000 deferred). Registered office: 149, Fenchurch Street, E.C.

G. W. K., Limited.—Capital, £5,000 in £1 shares, to carry on the business of ironfounders, etc. Registered office: 82, Victoria Street, Westminster, London, S.W.

Harvey & Company (Birmingham), Limited.—Capital £100 in £1 shares, to carry on the business of ironfounders etc. Registered office: 10, Union Passage, Birmingham.

Paul & M'Lachlan, Limited.—Capital £10,000 in £1 shares, to acquire and carry on the existing business of iron and brassfounders, etc. Registered office: Carronbank Foundry, Denny.

H. Hollingdrake & Son, Limited.—Capital £25,000 in £1 shares (10,000 preference), to carry on the business of iron and brass founders. Registered office: Heaton Norris, Lancashire.

J. H. Ballantyne & Company, Limited.—Capital £1,000 in £1 shares, to acquire and carry on the business of electrical and general engineers. Registered office: 80, Hyndland Road, Glasgow.

David Evans & Sons (Yniscedwyn), Limited.—Capital £4,000 in £1 shares, to carry on the business of iron and brass founders, etc. Registered office: Crane Foundry, Yniscedwyn, Ystradgynlais, S.O.

C. Whitaker & Company (Bradford), Limited.—Capital £2,000 in £1 shares, to take over the business of a general engineer carried on by A. Whitaker at the Canal Engineering Works, Bradford, as C. Whitaker & Company.

GANISTER, CUPOLA BLOCKS, FIRE BRICKS,
FIRE CLAY.
Silica Bricks, Tuyeres, Stoppers, Nozzles, &c.
STEEL MOULDERS' COMPOSITION, SILICA CEMENT.
J. GRAYSON LOWOOD & Co., Ltd.,
DEEPCAR, nr. SHEFFIELD.
Telegrams: "LOWOOD, DEEPCAR."

MEMORANDUM

To

From

Date

Subject

Reference

Signature

STRAIGHT LINE BUSINESS FORMS

MEMORANDUM

From

Booth & Brookes Limited.
Mildmay Ironworks.
Burnham on Crouch.
ESSEX.

TELEPHONE
No 9 BURNHAM ON CROUCH.

19

To

Established 1863.

JAS. DURRANS & SONS,

PHŒNIX WORKS, PENISTONE, Near Sheffield.

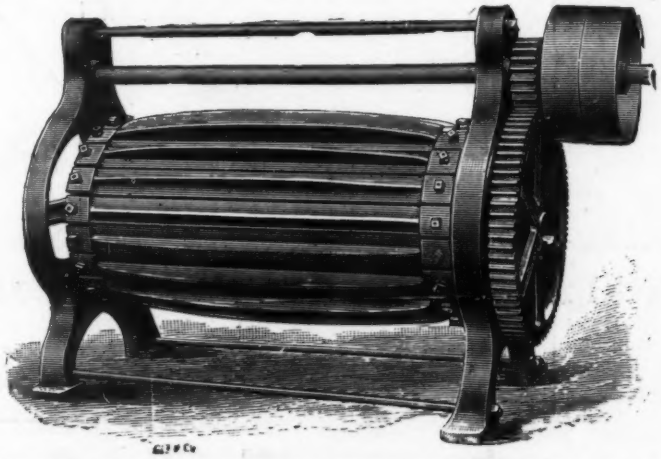
Manufacturers of all

FOUNDRY EQUIPMENTS,

COMPOSITION BLACK LEAD, PLUMBAGO, CORE GUM, WHITE DUST & COAL DUST.

Ladles, Cupolas, Fire Bricks, Gannister, Stone Flux, Loam and Sand Mills, Casting Cleaners, Studs, Chaplets, Pipe Nails, Sprigs, Brushes, Wire Brushes, Core Ropes, Bellows, Buckets, Spades, Forks, Riddles, Sieves, Barrows, Etc.

IMPROVED FOUNDRY RATTLER or FETTLING DRUM.



These Machines are invaluable for a Foundry, doing a larger amount of work of a superior quality, in a much shorter time than can be done by hand, without skilled labour.

"Dear Sirs,—We have been using your best Blacking for a large number of years, and always use it on our large Ingot Moulds, which, as you know, we have made up to 85 tons in weight.

Yours faithfully, THE BRIGHTSIDE FOUNDRY & ENGINEERING CO., LD."

Foundries Completely Equipped.

Cupola Hoists.

Cupolas.

Ladles.

Sand Mills.

Sifting and Mixing Machines.

FOR ALUMINIUM, BRASS, MALLEABLE, or STEEL.

MODERN FOUNDRY EQUIPMENT

ALL OUR Machines are designed and constructed for heavy duty, and will withstand for years the severest usage.

Write for . . . Catalogues.

Core Ovens.

Core Making Machines.

Moulding Machines.

Pig Breakers.

Tumbling Barrels.

Sand Blast Plants.

The London Emery Works Co., PARK WORKS,

TOTTENHAM, LONDON, N.

THE BUYER'S GUIDE

Addresses and further information will be found by reference to the Firm's Advertisement.

Abrasive Wheels.
Evans, J. & Co.
London Emery Works Co.
Jackman, J. W., & Co., Ltd.

Air Compressors.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Phillips, J. W. & C. J.
Thwaites Bros., Ltd.
Tilghman's Patent Sand Blast Co., Ltd.

Air Compressors (Electrically Driven).
Jackman, J. W., & Co., Ltd.
Marshall & Co. Horace P.
Tilghman's Patent Sand Blast Co., Ltd.

Air Compressors (Steam).
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Tilghman's Patent Sand Blast Co., Ltd.

Air Compressors (Belt).
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Tilghman's Patent Sand Blast Co., Ltd.

Annealing.
Evans, J. & Co.
Phillips, J. W. & C. J.

Ash Crushing and Washing Machines.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Phillips, J. W. & C. J.

Barrels (Tumbling).
Alldays & Onions Pneumatic Eng. Co., Ltd.
Evans, J., & Co.
Hall, Charles, & Co.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.
Marshall, H. P., & Co.
Phillips, J. W. & C. J.
Tilghman's Patent Sand Blast Co., Ltd.

Barrows.
Durrans, J., & Sons.
Evans, J., & Co.
Hall, Charles, & Co.
Jackman, J. W., & Co., Ltd.

Bellows.
Alldays & Onions Pneumatic Eng. Co., Ltd.
Evans, J., & Co.
Durrans, Jas., & Sons.
Hall, Charles & Co.
Jackman, J. W., & Co., Ltd.
Olsen, Wm.

Blacklead.
Durrans, J., & Sons.
Evans, J., & Co.
Hall, Charles, & Co.
Jackman, J. W., & Co.,Ltd.
Olsen, Wm.
Walker, I. & I.
Wilkinson & Co., Thos., Ltd.

Blowers.
Alldays & Onions Pneumatic Eng. Co., Ltd.
Buffalo Forge Co., Ltd.
Davies, T., & Son.
Dempster, R. & J., Ltd.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.
Marshall, H. P., & Co., Ltd.
Phillips, J. W. & C. J.
Samuelson & Co., Ltd.
Thwaites Bros Ltd.
Ward, T. W., Ltd.

Buffing and Polishing Machines.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.

Casting Cleaners.
Durrans, J., & Sons.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Pneumatic Engineering Appliances Co., Ltd.
Tilghman's Patent Sand Blast Co., Ltd.

Cement.
Dyson, J. & J.
Evans, J., & Co.
Hall, Charles & Co.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.
Lowood, J. Grayson, & Co., Ltd.
Marshall & Co., Horace P.
Olsen, Wm.
Plasti-Kion Co.
Silent Machine and Eng. Co.

Chaplets and Studs.
Durrans, J., & Sons.
Evans, J., & Co.
Hall, Charles, & Co.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Motherwell, Wm., & Co.
Olsen, Wm.
Wilkinson, T., & Co., Ltd.

Charcoal.
Evans, J., & Co.
Firminger, J. & Co., Ltd.
Hall, Charles & Co.
Jackman, J. W., & Co., Ltd.
Sykes, James.
Walker, I. & I.

Charging Platforms.
Alldays & Onions Pneumatic Eng. Co., Ltd.
Davies, T., & Son.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Thwaites Bros., Ltd.

Coal Dust.
Cumming, Wm., & Co., Ltd.
Durrans, J., & Sons.
Evans, J., & Co.
Hall, Charles & Co,
Jackman, J. W., & Co., Ltd.
Olsen, Wm.
Sykes, James.
Walker, I. & I.
Wilkinson & Co., Thos., Ltd.
Williams, John (Birmingham Sand) Ltd.

Coke (Foundry).
Elders Navigation Collieries.

Coke Breakers.
Evans, J., & Co.
Jackman, J. W. & Co., Ltd.
Marshall & Co., Horace P.
Phillips, J. W., & C. J.

Core Boxes.
Evans, J., & Co.
Jackman, J. W. & Co., Ltd.
Olsen, Wm.

Core Compounds.
Cumming, Wm. & Co., Ltd.
Durrans, J. & Sons.
Evans, J., & Co.
Hall, Charles, & Co.
Jackman, J. W. & Co., Ltd.
Olsen, Wm.
Wilkinson, Thos. & Co.

Core Gums.
Durrans, J. & Sons.
Evans, J., & Co.

Core Gums—*cont.*
Hall, Charles, & Co.
Jackman, J. W. & Co., Ltd.
Olsen, Wm.
Walker, I. & I.
Wilkinson & Co., Thos., Ltd

Core Making Machines.
Evans. J., & Co.
Hall, Charles & Co.
Jackman, J. W. & Co., Ltd.
London Emery Works Co
Marshall, H. P. & Co.
Phillips, J. W. & C. J.

Core Ovens.
Alldays & Onions Pneumatic Eng. Co., Ltd.
Evans, J. & Co.
Hislop, R. & G.
Jackman, J. W. & Co., Ltd.
London Emery Works Co.
Phillips, C. D.
Phillips, J. W. & C. J.

Core Ropes.
Durrans, J. & Sons.
Evans, J., & Co.
Hall, Charles, & Co.
Jackman, J. W., & Co., Ltd.
Olsen, Wm.
Wilkinson, T. & Co.

Core Vents.
Evans. J., & Co.
Hall, Charles & Co.
Jackman, J. W., & Co., Ltd.
Olsen, Wm.

Cranes.
Alldays & Onions Pneumatic Eng. Co., Ltd.
Evans, J. & Co.
Jackman, J. W., & Co., Ltd.
Vaughan & Son, Ltd.
Ward, T. W., Ltd.

Crucibles.
Evans, J. & Co.
Hall, Charles, & Co.
Olsen, Wm.

Crucible Furnaces.
Alldays & Onions Pneumatic Eng. Co., Ltd,
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.

Crucible Furnaces (Lift-out)
Alldays & Onions Pneumatic Eng. Co., Ltd.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Phillips, J. W. & C. J.

Crucible Furnaces (Tilting)
Alldays & Onions Pneumatic Eng. Co., Ltd.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Phillips, J. W. & C. J.

Crushing Mills.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.

Cupolas.
Alldays & Onions Pneumatic Eng. Co., Ltd.
Davies, T. & Son.
Durrans, J. & Sons.
Evans, J., & Co.
Hall, Charles & Co.
Jackman, J. W. & Co., Ltd.
London Emery Works Co.
Marshall, H. P. & Co.
Phillips, J. W. & C. J.
Thwaites Bros., Ltd.

Cupola Linings.
Evans, J., & Co.
Hall, Charles & Co.
Harris & Pearson.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.

Emery Grinders.
Alldays & Onions Pneumatic Eng. Co., Ltd.
Davis, T., & Son.
Evans, J., & Co.
Hall, Charles & Co.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.

Emery and Glass Cloth and Glass Paper.
London Emery Works Co.

Emery Wheels.
Alldays & Onions Pneumatic Eng. Co., Ltd,
Evans, J. & Co.
Hall, Charles & Co.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.
Mitchells Emery Wheel Co.

Facings.
Evans, J. & Co.
Olsen, William

Fans.
Alldays & Onions Pneumatic Eng. Co., Ltd.
Buffalo Forge Co.
Davies, T. & Son.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Jenkins, W. J. & Co., Ltd.
Phillips, J. W. & C. J.
Thwaites Bros., Ltd.

Firebricks.
Durrans, J. & Sons.
Dyson, J. & J.
Evans, J. & Co.
Fyfe & Co., J. R.
Harris & Pearson.
Jackman, J. W., & Co., Ltd.
King Bros.
Lowood, J. Grayson, & Co., Ltd.
Pearson, E. J. & J.

Foundry Blacking.
Cumming, Wm. & Co., Ltd.
Durrans, J. & Sons.
Evans, J., & Co.
Firminger, J. & Co., Ltd.
Hall, Charles, & Co.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.
Sykes, James.
Olsen, Wm.
Walker, I. & I.
Wilkinson, Thos. & Co., Ltd.
Williams, John (Birmingham Sand) Ltd.

Foundry Brushes.
Durrans, J. & Sons.
Evans, J., & Co.
Hall, C., & Co.
Jackman, J. W., & Co., Ltd.
Olsen, Wm.
Phillips, J. W. & C. J.

Foundry Ladles.
Alldays & Onions Pneumatic Eng. Co., Ltd.
Davies, T., & Son.
Durrans, J., & Sons.
Evans, J., & Co.
Hall, Charles, & Co.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.
Marshall, H. P., & Co.
McNeil, Chas.
Phillips, J. W. & C. J.
Thwaites Bros Ltd.

THE BUYER'S GUIDE.—*Continued.*

Foundry Rattlers or Fettling Drums.
Alldays & Onions
Davies, T., & Son
Durrans, J., & Sons
Evans, J., & Co.
Hall, Charles & Co.
Jackman, J. W., & Co.
London Emery Works Co.
Marshall & Co., Horace
Phillips, J. W. & C. J.

Foundry Sand.
Dyson, J. & J.
Evans, J., & Co.
Gould, George
Jackman, J. W., & Co., Ltd.
Wilkinson & Co., Thos., Ltd.
Williams, J. (Birmingham Sand), Ltd.

Furnaces (Annealing).
Alldays & Onions Pneumatic Eng. Co., Ltd.
Evans, J. & Co.
Hislop, R. & G.
Marshall & Co., Horace P.
Phillips, J. W. & C. J.

Furnaces (Brass).
Alldays & Onions Pneumatic Eng. Co., Ltd.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Phillips, J. W. & C. J.

Furnaces (Melting).
Alldays & Onions Pneumatic Eng. Co., Ltd.
Davies, T., & Son.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Phillips, J. W. & C. J.

Ground Gannister.
Durrans, J., & Sons.
Dyson, J. & J.
Evans, J., & Co.
Lowood, J. Grayson, & Co.
Walker, I. & I.

Grinding Machines and Tools.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.

Hammers (Steam).
Alldays & Onions Pneumatic Eng. Co., Ltd.
Thwaites Bros., Ltd.

Hay Band Spinning Machines.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Marshall &Co., Horace P.

Hoists.
Alldays & Onions Pneumatic Eng. Co., Ltd.
Davies, T., & Son.
Evans, J. & Co.
Jackman, J. W., & Co., Ltd.
Marshall, H. P., & Co., Ltd.
Phillips, J. W. & C. J.
Thwaites Bros., Ltd.

Loam and Sand Mills.
Davies, T., & Son.
Durrans, J., & Sons.
Evans, J., & Co.
Hall, Charles & Co.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Ward, T. W., Ltd.

Melting Furnaces (Oil fired)
Alldays & Onions Pneumatic Eng. Co., Ltd.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Phillips, J. W. & C. J.

Mould Driers.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Phillips, J. W. & C. J.

Moulding Machines.
Adaptable Moulding Machine Co., The
Britannia Foundry Co.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.
Marshall, H. P., & Co.
Phillips, J. W. & C. J.
Pickles, James.
Pneumatic Engineering Appliances Co., Ltd.
Samuelson & Co., Ltd.
Whittaker, Wm., & Sons, Ltd.

Moulding Machines (Hand and Power).
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Phillips, J. W. & C. J.
Pickles, James.

Pig Breakers.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.

Pig-Iron.
Bradley & Sons, T. & I., Ltd.
Frodsir Iron and Steel Co., Ltd., The
Goldendale Iron Co., Ltd.

Plumbago.
Cumming, Wm. & Co., Ltd.
Durrans, J., & Sons.

Plumbago—*cont.*
Evans, J., & Co.
Hall, Charles & Co.
Jackman, J. W., & Co., Ltd
London Emery Works Co.
Olsen, Wm.
Walker, I. & I.
Wilkinson & Co., Thos., Ltd.

Pneumatic Tools.
Jackman, J. W., & Co., Ltd.
J. Macdonald & Son, Ltd.
Marshall, H. P. & Co.
Pneumatic Engineering Appliances Co., Ltd.

Polishing Sundries.
Evans, J. & Co.
London Emery Works Co.

Publications.
Eagland & Co., Ltd.
Griffin, Charles & Co., Ltd.

Pyrometers.
Alldays & Onions
Phillips, J. W. & C. J.

Recording Gauges.
Evans, J. & Co.
Jackman, J. W., & Co., Ltd.
Phillips, J. W & C. J.

Riddles.
Durrans, J. & Sons.
Evans, J., & Co.
Hall, Charles, & Co.
Jackman, J. W., & Co., Ltd.
Olsen, Wm.
Wilkinson, Thos. & Co., Ltd.

Sand Blast Apparatus.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.
Phillips, J. W. & C. J.
Tilghman's Patent Sand Blast Co., Ltd.

Sand Driers.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.
Phillips, J. W. & C. J.

Sand Grinding Mills.
Evans, J., & Co.
Jackman, J. W. & Co., Ltd.
London Emery Works Co.

Sand Mixers.
Evans, J., & Co.
Halls Eng. Co.
Jackman, J. W. & Co., Ltd.
London Emery Works Co.
Marshall & Co., Horace P.
Phillips, J. W. & C. J.

Sand Riddling, Separating and Sifting Machines.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.
Marshall, H. P. & Co., Ltd.
Pneumatic Engineering Appliances Co., Ltd.

Sieves.
Durrans, J. & Sons.
Evans, J., & Co.
Hall, Charles, & Co.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.

Smiths' Hearths.
Alldays & Onions Pneumatic Eng. Co., Ltd.
Marshall & Co., H. P., Ltd.
Samuelson & Co., Ltd.
Thwaites Bros., Ltd.

Steel Moulders' Composition.
Dyson, J. & J.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Lowood, J. Grayson, & Co., Ltd

Spades and Shovels.
Durrans, J., & Sons.
Evans, J., & Co.
Hall, Charles & Co.
Jackman, J. W., & Co., Ltd.
Olsen, Wm.

Stone Flux.
Durrans, J., & Sons.
Evans, J., & Co.
Hall, Charles & Co.
Jackman, J. W., & Co., Ltd.
Wilkinson & Co., Thos., Ltd.

Stoppers and Nozzles.
Dyson, J. & J.

Straw Ropes.
Evans, J., & Co.
Hall, Charles, & Co.
Jackman, J. W., & Co., Ltd.
Olsen, William.
Wilkinson & Co., Thos., Ltd.

Testing Machines.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Marshall, H. P., & Co.
Phillips, J. W. & C. J.

Tuyeres (Firebrick).
Dyson, J. & J. [Ltd
Lowood, J. Grayson, & Co.

Welding. Thermit, Ltd.

FOR
IRONFOUNDERS' BLACKING, COAL DUST, ETC.
Registered "SHALAGO" Brand.
Write for Quotations to—
WILLIAM CUMMING & Co., LTD.,
IRONFOUNDERS' FURNISHERS.
WORKS— { Kelvinvale, Mills, Maryhill, Glasgow.
Whittington Blacking Mills, Chesterfield, Eng
Sunnyside Blacking Mills, Falkirk, N.B
TELEGRAPHIC ADDRESSES— { "Prudence, Glasgow."
"Cumming, Whittington, Chesterfield.
"Cumming, Blacking Mills, Camelon."

SITUATIONS VACANT AND WANTED.

FOREMAN MOULDER, smart, seeks engagement. Constructional, General Engineering, Jobbing, Plate, and Machine. Expert mixer and good organiser. First-class references.—Address Box 518, Offices of THE FOUNDRY TRADE JOURNAL, 165, Strand, London, W.C.

FIRM with good connection amongst Foundries, required to REPRESENT SPECIALITIES in Foundry Supplies.—Apply C.M., 1911, Offices of THE FOUNDRY TRADE JOURNAL, 165, Strand, London, W.C.

WANTED, FOREMAN MOULDER for Iron and Brass Foundry. Must be smart, energetic, with full knowledge of Mixed Foundry Work from 1 lb. up to 2 tons; Mixed Shop Repeat and Jobbing Work. Permanent situation to really good man, with bonus on results.—Full particulars, age, salary required, and when at liberty, to Box 521, Offices of THE FOUNDRY TRADE JOURNAL, 165, Strand, London, W.C.

WANTED, FOREMAN MOULDER, of at least 20 years' experience of Pipe-making and all kinds of Castings, about 40 years of age.—Address, giving full particulars, Box 523, Offices of THE FOUNDRY TRADE JOURNAL, 165, Strand, London, W.C.

FOR SALE AND WANTED.

PATTERN-MAKING.—All kinds of PATTERNS large or small, made to customers' designs, by experienced workmen; accuracy and prompt delivery guaranteed.—LAMBERT BROS., Engineers, Snodland.

FOR SALE, as a Going Concern, the oldest-established GENERAL ENGINEERING, IRON and BRASS FOUNDRY BUSINESS in Dublin. Splendid connection with Brewers, Distillers, Railway Companies, and others. New shops equipped with up-to-date Machinery, Tools, etc.—Full particulars on application to Box 527, Offices of THE FOUNDRY TRADE JOURNAL, 165, Strand, London, W.C.

THREE THWAITES RAPID MELTING CUPOLAS, 5 ft dia., 22 ft. 6 in. to charging door, with receivers and drop bottoms (Stewart's patent), capacity to melt 6 to 8 tons per hour, practically new condition.—Apply ROBSON Borough Engineering Works, Port Talbot.

FOR SALE AND WANTED.
(Continued.)

THE "ECLIPSE" SAND MIXER and GRINDER is the best for utilising Old Sand, Core Sands, Loam, and other Materials, mixed and prepared at lowest cost.—Apply HALL'S ENGINEERING CO., Hounds Gate Buildings, Nottingham.

WANTED, for Cash, Brass and Gun-metal Scrap Turnings, Condenser, and Loco. Tubes, Brass Dust, Mixed Metals, etc.—RAPID MAGNETTING MACHINE COMPANY, LTD., Crescent, Birmingham.

CHAINS for every purpose, including Mine and Incline Chains, Crane and Sling Chains, Steam Navvy and Dredger Chains, manufactured from tough and fibrous iron by skilled workmen.—MID-BRITISH CO., Corngraves Works, Cradley Heath.

3 CWT. STEAM HAMMER; two Single-ended; PUNCHING and SHEARING MACHINES, for hand or power; first-class condition. Will be sold cheap to clear.—Address to Box 525, Offices of THE FOUNDRY TRADE JOURNAL, 165, Strand, London, W.C.

CUPOLA, with 12 in. fan blow-pipes, and stand-pipes; two PITCH PINE TIMBERS, 30 ft., with overhead gantry, equal to new; Turned FLYWHEEL, 6 ft. 6 in. dia., 20 in. on face; about Four Tons 4 BOILER SHELL TANKS; Crossley GAS ENGINE, 8-b.h.p., M. type tube ignition; 20-h.p. Loco-type BOILER, for 80 lbs.—S. CLIFTON, 23, London Road, Nottingham.

S.M.S
WHAT IS IT?
SWIFT — METALLIC — STOPPING
The British Foundry Cement.
FOR FILLING UP BLOW HOLES IN CASTINGS.
IT DRIES IN ONE HOUR, AND IT CAN BE FILLED UP IN FROM SIX TO TWELVE HOURS.
SAMPLE FREE TRIAL TIN 1/-
AGENTS WANTED.
THE SILENT MACHINE COMPANY,
SAVILE STREET, SHEFFIELD.

"THE RIGHT ARTICLE AT THE RIGHT PRICE."
OLSEN'S ORIGINAL DOUBLE-TWISTED
STRAW ROPES
AND
WOOD WOOL CORE ROPINGS
— IN ALL SIZES. —
LARGEST STOCK. CARRIAGE PAID QUOTATION.
WM. OLSEN, COGAN STREET, — HULL. —

FIRE BRICKS & CLAY
CUPOLA BRICKS.
BEST QUALITY.
LESSEES OF DELPH AND TINTERN ABBEY BLACK AND WHITE CLAY.
KING BROTHERS,
(STOURBRIDGE) Ltd.,
STOURBRIDGE.

COMPLETE SAND BLAST APPARATUS

For Cleaning large and small Castings.

WILL SAVE 50 PER CENT. IN FETTLERS' WAGES.

IN USE BY THE FOLLOWING WELL-KNOWN FIRMS:—

STEEL CASTINGS.

Beardmore, W., and Co., Ltd.	Glasgow.
Steel Co. of Scotland	Glasgow.
Coltness Iron Co.	Coltness.
Dickson and Manns, Ltd.	Armadale.
Vickers, Sons and Maxim, Ltd.	Barrow.
Darlington Forge Co., Ltd.	Darlington.
Shaw, W., and Co.	Middlesbrough.
Hadfields' Steel Foundry Co., Ltd.	Sheffield.
Osborn, S., and Co., Ltd.	Sheffield.
Jackson, P. R., and Co., Ltd.	Manchester.

MALLEABLE IRON.

Ley's Malleable Castings Co., Ltd.	Derby.
Crowley, John, and Co., Ltd.	Sheffield.
Baker Foundry Co., Ltd.	Smethwick.
Maddock, J., and Co., Ltd.	Oakengates.
Clegg and Howgate, Ltd.	Keighley.
Croft Foundry Co., Ltd.	Walsall.
Lindop, H. W.	Walsall.
Tangyes Ltd.	Birmingham.
Harper, J., and Co.	Willenhall.
Haden, G. N., and Sons	Trowbridge.

ORDINARY IRON CASTINGS.

Platt Bros. and Co., Ltd.	Oldham.
Tweedales and Smalley	Castleton.
H.M. Dockyards	—
Dobson and Barlow, Ltd.	Bolton.
Doulton and Co., Ltd.	Paisley.
Ruston, Proctor and Co., Ltd.	Lincoln.
Marshall, Sons and Co., Ltd.	Gainsborough.
Shanks and Co., Ltd.	Barrhead.
Falkirk Iron Co.	Falkirk.
Hopkinson and Co.	Huddersfield.

BRASS OR GUN METAL.

Vickers, Sons and Maxim, Ltd.	Barrow.
Gummer and Co.	Rotherham.
Ruston, Proctor and Co., Ltd.	Lincoln.
Storey, Isaac and Sons, Ltd.	Manchester.
Glenfield and Kennedy	Kilmarnock.
Milne, J., and Son	Edinburgh.
Benton and Stone	Birmingham.
British Insulated and Helsby Cables, Ltd.	—
Marshall, Sons and Co., Ltd.	Gainsborough.
Dewrance and Co.	London.

General Representative: GEO. HOPKINS, 63, Quarrenden Street, King's Road, Fulham, London, S.W.

TILGHMAN'S PATENT SAND BLAST Co., Ltd.,

BROADHEATH, Nr. MANCHESTER.

WHITTAKER'S IMPROVED MOULDING MACHINE

By which Wheels or Pulleys of any description or size from 3 inches to upwards of 20 ft. diameter can be made.

The most complete and efficient machine hitherto introduced to Engineers.

All Machines warranted to Mould with the greatest accuracy and precision.

GEARING WHEELS

Spur or Bevel, Straight Teeth and Double Helical Teeth Supplied to Consumers.

ROPE & BELT PULLEYS.

WM. WHITTAKER & SONS, LTD.,

SUN IRON WORKS, ***OLDHAM.***

Index to Advertisers.

Addresses, Telegraphic Addresses, and Telephone Numbers.

PAGE NO.	NAME.	ADDRESS.	TELEGRAPHIC ADDRESS.	TELEPHONE NO.
	Adaptable Moulding Machine Co. The	Bishop Street, Birmingham	—	—
	Alldays & Onions, Ltd....	Birmingham	Alldays, Birmingham	328 Victoria
C. ii.	Bradley, T. & I., & Sons, Ltd.	Darlaston	—	—
186	Britannia Foundry Co.	Coventry	Stoves, Coventry	251
C. iii.	Buffalo Forge Co.	Caxton House, London	Buffaloes, London	Victoria 420.
234	Cumming, William, & Co., Ltd.	Maryhill, Glasgow	Prudence, Glasgow	P.O. M. 25
C. ii.	Dempster, R. & J., Ltd.	Oldham Road, Manchester	—	—
183	Davies, T. & Sons	West Gorton, Manchester...	Tuyere, Manchester	70 Openshaw
231	Durrans, Jas., & Sons	Penistone, nr. Sheffield	Durrans, Penistone	—
185	Dyson, J. & J.	Sheffield	Dyson's, Stannington...	702 Sheffield
229	Elders' Collieries Ltd.	Cardiff	Elder, Maesteg	10
190,227	Evans, J., & Co.	Manchester	Ladles, Manchester	2297
186	Everitt & Co.	40, Chapel Street, Liverpool	Persistent, Liverpool	1134 Central (3 lines)
	Firminger, J. & Co., Ltd.	Walworth, London, S.E. ...	—	—
235	Frodair Iron & Steel Co., Ltd.	5, Fenchurch Street, E.C.	Frodair, London	—
184	Fyfe, J. R. & Co.	—	—	—
	Goldendale Iron Co., Ltd.	Tunstall, Stoke-on-Trent	—	—
184	Gould, George	Old Canal Wharf, Stourbridge... ...	—	—
	Hall, Charles & Co.	Dantzic Street, Manchester	—	5814 City
181	Harris & Pearson...	Stourbridge	Fireclay, Stourbridge	7 Brierley Hill
186	Hislop, R. & G.	Paisley	Gas, Paisley	331 Paisley
184	Hodges & Co.	—	—	—
C. iv.	Jackman, J. W., & Co.	Caxton House, S.W.	Molders, London	30 Victoria
187	Jenkins, W. J. & Co.	—	—	—
182	King, Bros. (Stourbridge), Ltd.	Stourbridge	King Bros., Stourbridge	—
232	London Emery Works Co., Ltd.	Park, Tottenham	Naxium, London	99 Tottenham
230	Lowood, J. Grayson, & Co., Ltd. ...	Deepcar, nr. Sheffield	Lowood, nr. Sheffield	18 Stocksbridge
187	Macdonald, J. & Son, Ltd.	Maryhill, Glasgow	Compressor, Glasgow	161 Mary Hill
	Marshall, H. P., & Co.	Leeds	Specialty, Leeds	909 Lee ds
185	Mitchell's Emery Wheel Co.	Bradford, Manchester	—	—
184	McNeil, Chas.	Kinning Park, Glasgow	McNeil, Glasgow	X 155
182	Olsen, William	Cogan Street, Hull	Wm. Olsen, Hull	590 Y.I.
	Phillips Chas. D.	Newport, Monmouthshire	Machinery, Newport	18 P.O. 576
182	Phillips J. W. & C. J.	23, College Hill, E.C.	Colloquial, London	10112 Central.
C. iii.	Plasti-Kion Co., The	Caxton House, S.W.	—	—
	Pneumatic Eng. Appliances Co., Ltd.	Palace Chambers, Westmntr. S.W ...	Pneumogram, London...	856P.O. Victoria
230	Silent Machine Co.	Albion Works, Salile St., Sheffield.	Forward, Sheffield	
188	Samuelson & Co.. Ltd.	Banbury	Samuelson, Banbury	—
	The Standard Sand Co., Ltd.	Mansfield	Standard Sand Co., Mansfield...	201 Mansfield
182	Sykes, James	Ashton-under-Lyne.	—	—
229	Thermit, Ltd.	27, Martin's Lane, E.C.	Fulmen, London	3719 Central
236	Tilghman's Patent Sand Blast Co., Ltd. ...	Broadheath, nr. Manchester	Tilghmans, Altrincham	14
189	Thwaites Bros., Ltd.	Bradford	Thwaites, Bradford	325 Bradford
	Vaughan & Sons, Ltd.	West Gorton, Manchester	Vaunting, Manchester	5113 Central
C. ii.	Walker, I. & I.	Rotherham	—	—
236	Whittaker, W., & Sons, Ltd.	Oldham	Whittakers, Engineers, Oldham	83
185	Wilkinson, Thos., & Co., Ltd.	Middlesbrough	Blacking. Middlesbro.	419
230	Williams, J. (B'ham Sand) Ltd.	Birmingham	—	—

STOURBRIDGE FIRE BRICKS

Of Best Quality for Lining Cupolas in Stock,

ALSO MADE TO ANY DESIGN.

Linings Stocked to Customers' Plans to ensure IMMEDIATE DELIVERY.

All kinds of Fireclay Goods of Highest Quality.

HARRIS & PEARSON, STOURBRIDGE.

Telegrams:—"FIRECLAY, STOURBRIDGE." **Telephone:—No. 7 Brierley Hill.**

"THE RIGHT ARTICLE AT THE RIGHT PRICE."

OLSEN'S ORIGINAL DOUBLE-TWISTED

STRAW ROPES

AND

WOOD WOOL CORE ROPINGS

IN ALL SIZES.

LARGEST STOCK. CARRIAGE PAID QUOTATION.

WM. OLSEN, COGAN STREET, HULL.

FIRE BRICKS & CLAY

CUPOLA BRICKS.

BEST QUALITY.

LESSEES OF DELPH AND TINTERN ABBEY BLACK AND WHITE CLAY.

KING BROTHERS,

(STOURBRIDGE) Ltd.,

STOURBRIDGE.

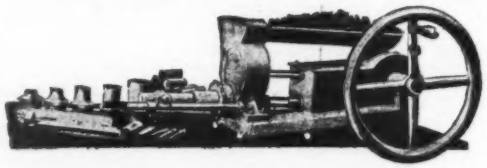
Ironfounders' Charcoal Blacking, Mineral Blacking, Coal & Coke Dust Manufacturer, &c.

JAMES SYKES, HURST CHARCOAL MILL, Near ASHTON-UNDER-LYNE.

ESTABLISHED 1854.

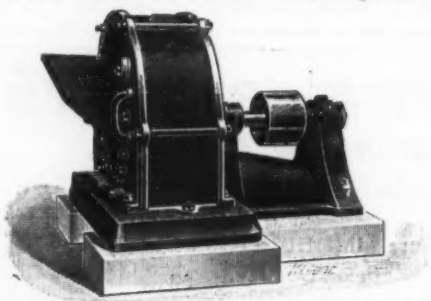
THE SWEDISH PATENT

"PERFECT" CORE MACHINE



supersedes all the machines with screws, which wear out. It works with a plunger, and is built to last. No oil or binder is required. Some hundreds giving satisfaction in Sweden, Norway, England, Germany, Russia, &c.

The Best and Cheapest SAND MIXER on the Market.



Output 2 tons per hour.

Also

Single-Ended Type 4 tons per hour.

Double-Ended Type 4 tons per hour.

All three are new designs and strongly built with Gunmetal bearings and self-oiling rings. Also special Hard Steel Bars which can be renewed.

J. W. & C. J. PHILLIPS, 23, COLLEGE HILL, CANNON STREET, LONDON, E.C.

T. DAVIES & SON,

RAILWAY WORKS, WEST GORTON, MANCHESTER.

ON ADMIRALTY LIST.

Telegrams—"TUYERE, MANCHESTER. Nat. Telephone—No. 70, OPENSHAW.

Specialities

FOUNDRY CUPOLAS & LADLES

ALL TYPES AND SIZES IN STOCK OR PROGRESS.

LICENSEES and MAKERS of

Osborn's Patent Spark Arrester

FOR FOUNDRY CUPOLAS.

Efficient. Simple in Design.

Require no Attention.

Prevent Fire or Damage to Surrounding Buildings.

SAVE THE COST OF FREQUENT CLEANING OF THE ROOFS AND GUTTERS.

THOROUGHLY RELIABLE.

HODGES PATENT TURBINE BLOWERS.

40% Less Power to Drive than any other Blower.

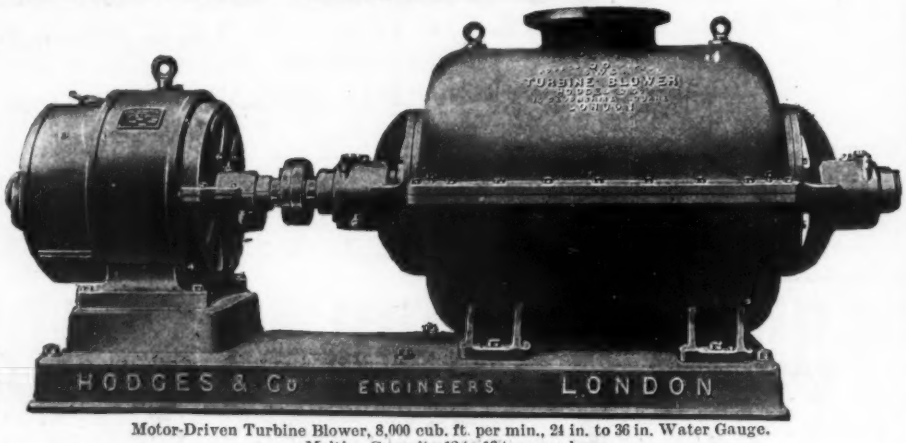
NO INTERNAL FRICTION.

NO NOISE.

NO WEAR AND TEAR.

PERFECTLY STEADY. BLAST PRESSURE

Direct-Coupled toElectro-Motor, Steam Turbine, Petrol Engine or with Pulley for Belt Driving.



Motor-Driven Turbine Blower, 8,000 cub. ft. per min., 24 in. to 36 in. Water Gauge. Melting Capacity 12 to 16 tons per hour.

Made in 8 Standard Sizes, Capacities 50 to 15,000 Cubic feet per min.

VARYING PRESSURES UP TO **20 lbs.** PER SQUARE INCH.

For BLAST FURNACES, STEEL CONVERTERS, CUPOLAS, SMITH'S HEARTHS and OTHER PURPOSES

HIGHEST CLASS BRITISH MATERIAL AND WORKMANSHIP.

***R. J. HODGES & CO.,* ENGINEERS, 14, DEVONSHIRE SQUARE, BISHOPSGATE, LONDON, E C.**

38½"
McNEIL'S PATENT UNBREAKABLE STEEL LADLES.
These Ladles are manufactured by a patented process, each from a single steel plate without weld or rivet. They are extremely light, being at the same time the strongest and most durable in the market. Ladles to contain 56 lb. of metal only weigh about 7 lb. each. They are made of all capacities from 30 lb. to 60 cwt., with or without lips; also mounted or unmounted. They are also suitable for chemical or metallurgical processes. List of sections and prices on application to
CHAS. McNEIL.
KINNING PARK IRONWORKS, GLASGOW.
36"
32½"

Can also be made in Aluminium.

CUPOLA BRICKS

FOR LINING ORDINARY AND PATENT

CUPOLA FURNACES.

JOHN R. FYFE & Co.,

SHIPLEY, Yorks.

GEORGE GOULD,

OLD CANAL WHARF,

STOURBRIDGE.

FOUNDRY SAND

(MINE OWNER).

IRON AND COAL MERCHANT.

PROMPT DELIVERIES BY TRUCK OR BOAT.

Sole Makers of **"PEHRSON'S PATENT STEEL MOULDERS' GREENSAND."**

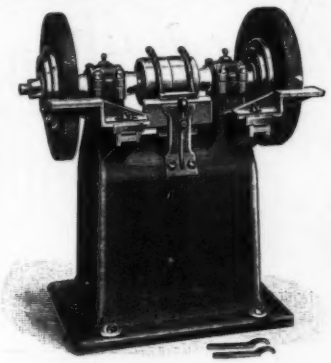
GROUND GANNISTER, STEEL MOULDERS' COMPOSITIONS, SILICA CEMENT.

Gannister Bricks, Fire Bricks, Stoppers and Nozzles. Crucible Clay for all Purposes.

J. & J. DYSON, SHEFFIELD GANNISTER WORKS, ATTERCLIFFE ROAD, **SHEFFIELD.**

Telegrams—"DYSON'S, STANNINGTON." Telephone—No. 702 SHEFFIELD.

HIGH-CLASS GRINDING WHEELS FOR ALL WORK.



UP-TO-DATE GRINDING MACHINES OF ALL TYPES.

MITCHELL'S EMERY WHEEL CO.,

Castle Works, Bradford, MANCHESTER.

: : SEND FOR NEW ILLUSTRATED LIST. : :

TELEPHONE : 3575 CENTRAL. TELEGRAMS : DIAMETER, MANCHESTER.

ON ADMIRALTY, WAR OFFICE, and INDIA OFFICE LISTS.

"CARLTON" PATENT BLACKING

may not be the cheapest but it is the BEST and ONLY reliable "ALL ROUND" Blacking on the market. It is extensively used in Great Britain and Colonies for Flat and Round Stove and Range Work, Baths, Furnace Pots, Jobbing Work up to 40 tons, Light and Heavy Engineering Castings, Ingot Moulds, &c., &c.

Send for Free Trial Sample and Price.

THOMAS WILKINSON & CO., LTD., FOUNDRY STORES, **MIDDLESBROUGH.**

FERRO-VANADIUM. * * * **FERRO-TITANIUM.**

SILICO-MANGANESE {**23/30** % Silicon, {**65/70** % Manganese & **1** %, **2** %, **3** %, Carbon Maximum.

FERRO-SILICON Containing **25** %, **50** %, **75** % Silicon.

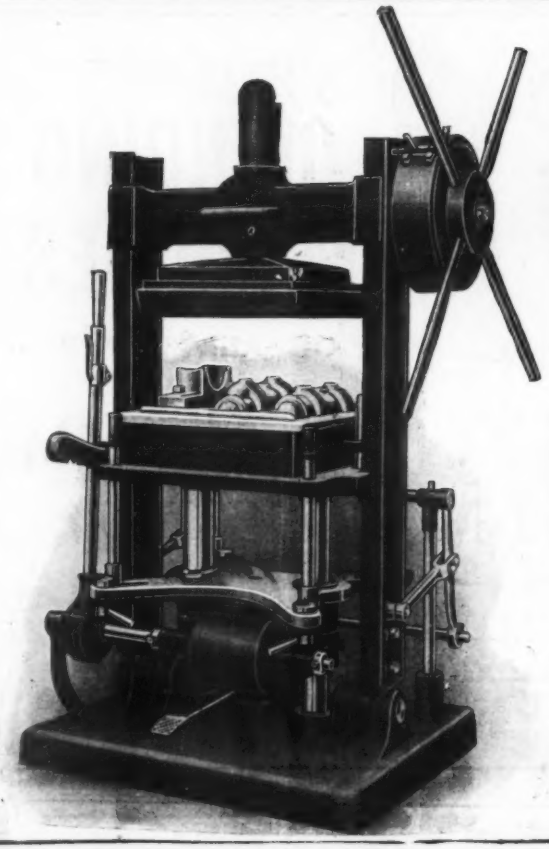
FERRO-CHROME **65/70** % Cr. & **1** % up to **8/10** % Carbon Maximum.

ALUMINIUM **98/99** % Purity. *In Notched Bars and Half Round Sticks and Granular.*

WE SUPPLY ALL CLASSES OF MINERALS, METALS AND METALLIC ALLOYS.

EVERITT & CO., 40, CHAPEL ST., LIVERPOOL.

Telegrams: "PERSISTENT." Telephone No. 1134 (3 lines).



ONE

"Coventry" Patent Moulding Machine

will turn out more accurate and consistent work than 5 hand Moulders.

PRICE from £30.

GUARANTEED RAMMING POWER

From 3 to 12 TONS PRESSURE

ON MOULD without exertion to the Operator.

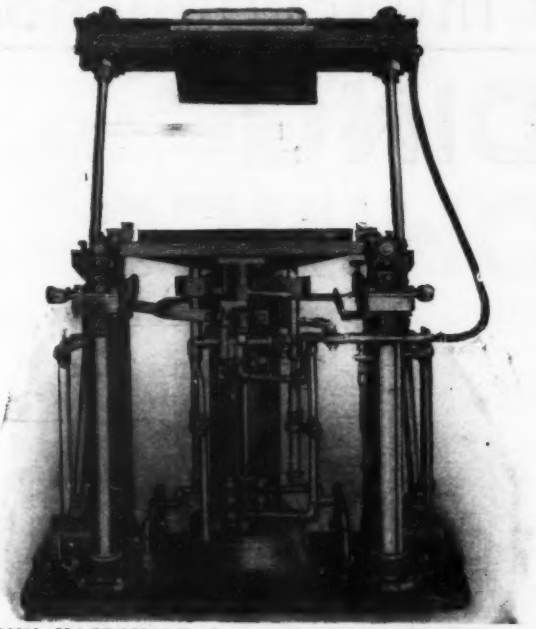
Write for Catalogue to the Makers.

BRITANNIA FOUNDRY CO.
COVENTRY, ENGLAND.

EFFICIENT AND ECONOMICAL HEATING OF FOUNDRY STOVES, . . . ANNEALING OVENS, FURNACES, &c. . . .

R. & G. HISLOP,

Gas Engineers, Underwood House, PAISLEY.



JOHN MACDONALD & Son, Ltd., Moor Buildings, Pilgrim Street, Newcastle-on-Tyne.
JOHN MACDONALD & Son, Ltd., Norwich Union Chambers, Birmingham.
JAMES R. KELLY & Co., Bridge End, Leeds Bridge, Leeds.

Telegrams :—"Compressor, Glasgow."
Telephones :—National, 61 Maryhill, Post Office, 69 Kelvin.

John Macdonald

—— & SON, Limited. ——

Pneumatic Engineers,

WATT ST., MARYHILL, GLASGOW

"Ajax" Pneumatic Combined Jolting and Power Press Moulding Machine.

The Machine that is suitable for deep and shallow work.

The Machine that will make a complete mould in a few seconds without any hand work, forms the sand hardest about the pattern.

Inquiries and Correspondence Invited.

British Made Pneumatic Appliances for the Foundry.

GAS CLEANING FANS

For Producer, Blast Furnace and other Gases.

Undoubtedly the most Successful Fan for the Purpose on the Market.

W. J. JENKINS & CO., LTD.,

GAS ENGINEERS, etc.,

RETFORD.

IMPORTANT TO IRONFOUNDERS.

MOULDING—
—MACHINES

FOR REPETITION FOUNDRY WORK.

Illustration of

HAND PRESS MACHINE

for Small Repetition Work, giving rapid and Economical Production.

Makers also of a

HAND RAMMING MACHINE

where a Deep Lift is required. Can be Operated by

UNSKILLED LABOUR.

MOST EFFICIENT AND ECONOMICAL IN USE.

Also Makers - - of - - ROOTS' "ACME" BLOWERS.

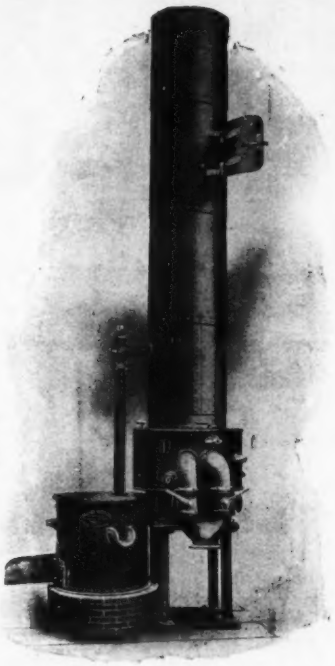
FULL PARTICULARS FROM—

Samuelson & Co., Ltd., Banbury,

ENGLAND.

SEE OUR ADVERTISEMENT EVERY ALTERNATE MONTH.

FOUNDRY PLANT.



"Rapid" Cupolas

WITH OR WITHOUT RECEIVERS OR DROP BOTTOMS.

Roots' Blowers

FOR ENGINE, BELT, OR ELECTRIC DRIVING.

STEAM HAMMERS,
FORGE PLANT,
ROOTS' BLOWERS,
"RAPID" CUPOLAS,
FOUNDRY PLANT,
CENTRIFUGAL PUMPS,
AND FANS.
HIGH SPEED ENGINES
WITH
FORCED LUBRICATION
A SPECIALITY.
THE "BRADFORD" PATENT
BOILER FEED PUMP.
CATALOGUES ON APPLICATION.

THWAITES BROS., Ltd.,

BRADFORD.

LADLES, HOISTS,
PLATFORMS,
JIB CRANES, Etc.

London Office—

96 & 98, Leadenhall Street, E.C.

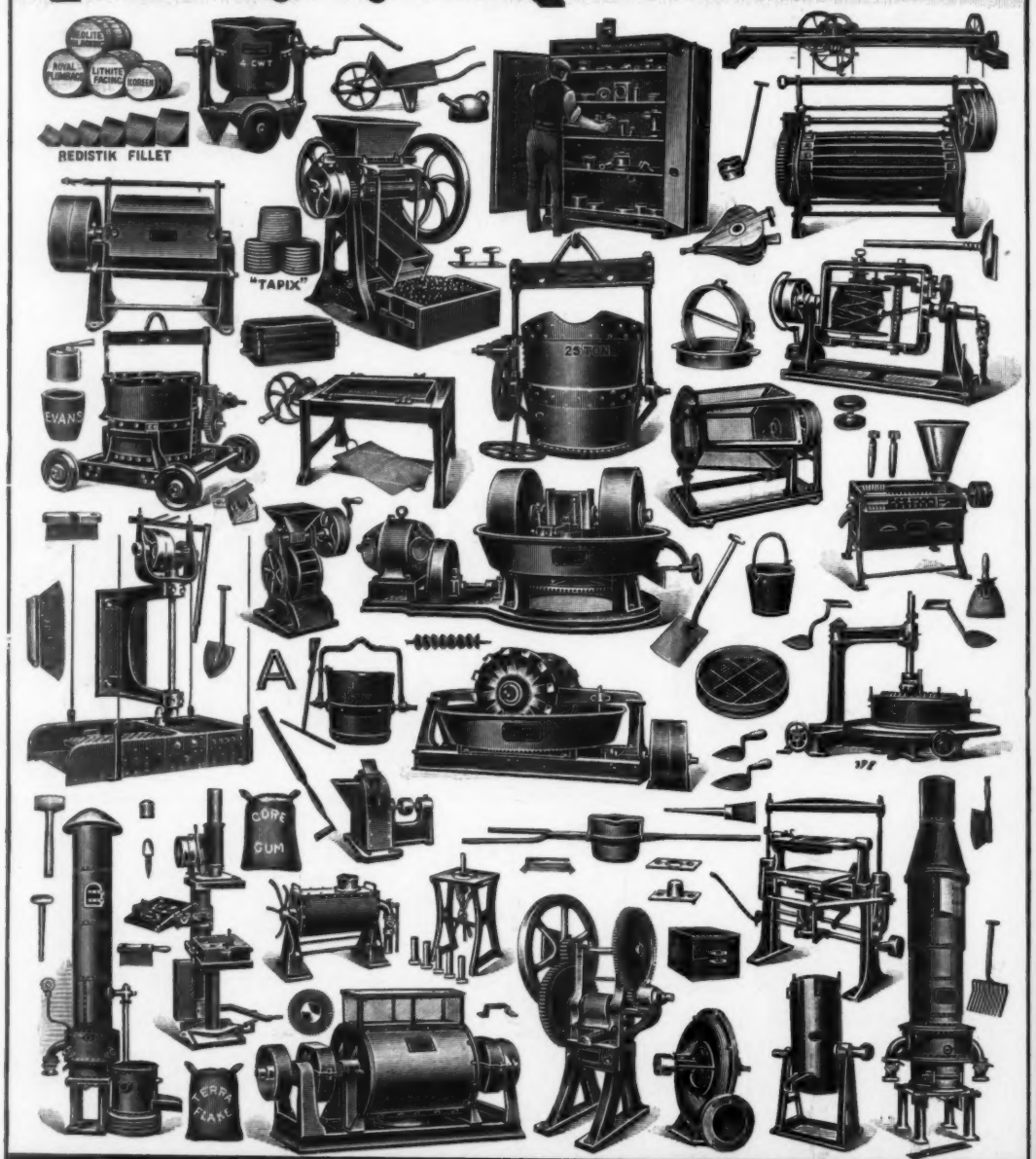
B

COMPLETE

Foundry Equipment.

Telegrams: "LADLES" MANCHESTER

Telephone: "No 2297 CENTRAL" MANCHESTER.



JAMES EVANS & Co. BRITANNIA WORKS, BLACKFRIARS. MANCHESTER.